INTERNATIONAL
Chemical Engineering
and Process Industries

Vol. 33, No. 2 FEBRUARY 1952

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Subscription rates: 1 year 4 dollars, 3 years 8 dollars, paid in advance
England: Leonard Hill Limited, 17 Stratford Place, London, W.1 *U.S.A.: British Publications Inc., 150, East 35th St., New York, 16*

Topics of the Month

'CHEMICAL AND PROCESS ENGINEERING'

BEGINNING with the April issue, the title of this journal will be changed to

'CHEMICAL AND PROCESS ENGINEERING'

The change is being made because the new title expresses more accurately and fully the scope and purpose of this journal. This purpose is to record progress in the development of chemical plant and operations for all industries all over the world. Examples of these industries are those producing Chemicals, Pharmaceuticals, Food, Fertilisers, Insecticides, Paint, Petroleum, Fuels, Oils and Fats, Soap, Detergents, Cosmetics, Perfumery, Plastics, Rubber, Textiles, Metals, Building Materials, Pulp and Paper.

Oil refining in Europe

THE establishment of a great oil refining industry in Europe during the past few years is a remarkable, if little publicised, example of successful international co-operation. Before the war the throughput of European oil refineries was about 11,000,000 tons per annum. By next year it is expected that throughput will be nearly six times as much, slightly more than enough to meet European requirements. 'European' in this context means Western Europe or, more specifically, those 15 countries which form the Organisation for European Economic Co-operation. Through this organisation the 15 countries formulated a programme for oil refinery development, bearing in mind three main factors: (1) The need to match consumption requirements with a balanced refinery output. (2) The need to avoid high internal prices or other special measures to secure and protect refinery output. (3) The avoidance of an expansion in refinery capacity to the point at which exportable surpluses were produced for which there was no readily foreseeable market.

Home refining is not necessarily a true economic gain to a country which must import crude oil. The chief stimulus to the development of the European refining industry was the need to cut down the dollar burden. In addition, however, there are certain other undeniable advantages in a country having its own refining industry. Perhaps the most important are that greater flexibility in supply is made possible, that a petroleum chemicals industry can be built up, and that ancillary refinery supply industries (equipment, transport, catalysts, etc.) can be created.

European engineering concerns have not been slow to take advantage of the new market placed on their doorstep and they have been so successful in producing a wide range of refinery plant and equipment that they can now compete with the long-established American petroleum equipment industry. Many specialised items of equipment must still be imported from America, but this need will gradually diminish. Thus, European suppliers will continue to take an increasing share of the $1,018,000,000, which is the cost of the European refinery expansion programme during the period 1948-54.

Beyond the oil age

IN considering the relative importance of coal and petroleum as fuels and raw materials it is salutary to bear in mind these facts: 95.5% of the known mineral fuel reserves of the United States consists of coal. Proved petroleum and natural gas comprise only 1% of the total. The rest consists of oil recoverable from oil shale.

The significance of these facts is that, however much the petroleum industry develops as a competitor of coal for fuel and chemicals, its career is likely to be a relatively short one. Eventually America, and the rest of the world, will have to rely on coal for both solid and liquid fuels and for chemical raw materials. It may be that we are now witnessing the zenith of the oil industry and that from henceforth it will slowly decline, bringing a corresponding rise in the importance of coal.

These thoughts are prompted by a few paragraphs in the British Productivity Team's Report on Coal. Most of this excellent document (Anglo-American Council on Productivity, 3s. 6d., post free) is concerned with coal mining, but in a page or two at the end the team indulge in a few forecasts of the probable future role of coal. In the U.S. they visited the Bruceton Experimental Station of the Bureau of Mines and saw work in progress on two oil-from-coal processes, the Fischer-Tropsch and Bergius processes. In Missouri they saw in operation a 200 barrels day hydrogenation unit and a nearly completed 50 barrels day synthesis gas plant. Neither process is yet economic, but it is understood that the cost of production at the present low selling price of coal (in America) has been reduced to within a few cents of the selling price of conventional fuel spirits. It needs only a slight variation of costs (downward in these processes or upward in the oil industry) or a greater national need to make oil-from-coal a commercial proposition. The coal industry in the U.S., which in recent years has lost ground heavily in the railway market, may well regain it by the establishment of processes for the conversion of coal to diesel fuel.

Simultaneously with these experiments the Bureau of Mines is carrying out an extensive research and development programme on the production of synthesis gas and on the complete gasification of lignite and sub-bituminous coal. Several of the larger companies are doing similar work independently.

In the coal chemicals field, in America as elsewhere, the coal companies have left other industries to develop the more refined products. The team heard of one chemical company that is buying up reserves of coal and another that is building a coal hydrogenation plant, of which chemicals will be the primary and fuels the by-products.

The team's general conclusions are that in the U.S. the long-term trend appears to be to regard coal almost as an ore; revolutionary methods will get it out of the ground even more quickly and cheaply and it will be made into a fuel on the surface. The greater part of the reserves are of low rank and grade and ultimately the chances of meeting still more stringent demands with a natural though 'prepared' product seem remote. More elaborate processing, *e.g.* carbonisation, briquette carbonisation, liquefaction or gasification, will be necessary if these reserves are to be used effectively when the time comes.

Developments in a variety of fields show that it is already technically feasible, by treating coal as a raw material, to satisfy total U.S. requirements for several hundred years not only for solid fuels, but also for liquid and gaseous fuels, and at the same time to provide chemicals and raw materials for many industries. The *relative* paucity of proved oil and gas reserves, and the distribution of coal reserves both geographically and by types, appear to make some such course inevitable. There are thus visionary thoughts of coal undertakings becoming manufacturers of fuels of all kinds and of many other things.

A new source of uranium

OWING to the general increase in the use of chemical fertilisers all over the world, there is a commensurate rise in the consumption of phosphatic fertilisers. This means an increase in the use of phosphate rock and, surprisingly enough, this development is of direct importance to the atomic energy industry. It appears that in the United States uranium, major raw material of atomic energy, is being extracted as a by-product of the manufacture of fertilisers from phosphates found in Florida and several western states. This was disclosed by an official of the Raw Materials Division of the U.S. Atomic Energy Commission at a recent meeting of American fertiliser manufacturers. He said that uranium was present in certain phosphate deposits in amounts ranging from 0.2 to 0.4 lb./ton. Since the consumption of phosphates by the fertiliser industries of the world runs into millions of tons, it is clear that this material is a very considerable potential source of uranium. The U.S. Atomic Energy Commission is now trying to devise an effective and economical process for the optimum recovery of uranium from phosphate fertiliser manufacture and no doubt this work will be followed up in other countries.

How more fertilisers could be made in South Africa

UNTIL the production capacity of South Africa's fertiliser plants is expanded and larger sources of raw materials are found it is expected that output of fertilisers in the Union will remain at about the present annual figure of 650,000 to 700,000 tons. Two plants of African Explosives and Chemical Industries Ltd. produce phosphatic mixtures; one has a capacity of 240,000 tons and the other 410,000 tons. These plants could produce an additional 50,000 tons annually if they made superphosphate, as the manufacture of the mixtures requires the handling of additional material, which tends to reduce output. Plans call for production of approximately 630,000 tons by these plants in the July 1951-June 1952 period.

African Explosives and Chemical Industries Ltd. is interested in expanding plant facilities at Dorowa, Southern Rhodesia, which is near large deposits of phosphate rock. Work on a new plant at Modderfontein, near Johannesburg, is progressing and the factory is expected to be in operation in 1953.

The U.S. wants more nitrogen

THE Defence Production Administration in the U.S. has set new goals for the production of nitrogen and phthalic anhydride, important in the production of rocket propellants and explosives. The Administration has announced it will issue fast tax write-off allowances to manufacturers who expand such production facilities. The D.P.A. wants nitrogen production in the U.S. increased to 2,930,000 tons annually by 1955; this is nearly double the January 1950 production of 1,540,000 tons.

The D.P.A. already has in sight 890,000 tons of its total nitrogen expansion of 1,390,000 tons. About 160,000 tons will be provided by a military ordnance plant at Morgantown, West Virginia. Another 60,000 tons is being provided by the industry without Government assistance and 670,000 tons will be provided by projects now under way which have received accelerated amortisation permits from the Government.

A goal of 367,700,000 lb. of phthalic anhydride production by 1955—a jump of 140,000,000 lb. over capacity on January 1, 1951—has been set by the D.P.A.

Fuel oil in industry

THE shortage of coal in Britain, which, in spite of increased mechanisation in the pits, is likely to continue and probably grow worse, makes it instructive to examine the various industries in which fuel oil can be a satisfactory or better substitute for coal as a source of energy. In his recent presidential address to the Fuel Luncheon Club, Mr. H. Cunliffe emphasised that these fuels should be regarded as being complementary to one another, and that their use in any field ought to be considered on the basis of their suitability for each individual application and their contribution to industrial efficiency.

He suggested, in particular, that the major criteria should be whether by using oil instead of coal better goods can be produced and fewer B.Th.U.s per unit of output used, and whether operating conditions can be improved and labour requirements reduced. If these criteria are applied to the steel industry, for example, the use of fuel oil would seem preferable to that of coal. Results indicate that from 10% to 15% more output can be obtained from an oil-fired furnace than from present producer gas furnaces, and that whereas 7,000,000 B.Th.U.s are put into the producers for each ton of ingots produced, only 4½ to 5 million B.Th.U.s of oil are required.

In the pottery industry the advantages of using oil are equally plain, and there are many tasks in metallurgy that are equally suitable. Drying operations of such agricultural products as hops, malt, grain and grass can all benefit from the employment of fuel oil, while the diesel engine still remains the most efficient prime mover, although its use for passenger rail traction in Britain has not yet been developed to any large extent.

On the other hand, the ordinary works boiler and the modern power station boiler can probably obtain no particular benefit from oil firing, as there would be virtually no saving in B.Th.U.s and little saving in labour. Since there are, however, very many industries in which fuel oil can supply energy more efficiently than coal, it is to be hoped that more attention will be paid in the future to making use of this greater efficiency. British industry should depend as much on the use of oil in its proper spheres as on the use of coal and its derivatives in theirs.

Record production of rayon

THE output of the British rayon industry has reached a record level, being, in fact, treble the pre-war figure. In 1950, 16,500,000 lb./month of continuous filament yarn and 14,500,000 lb. staple fibre were produced, compared with 9,000,000 lb. and 920,000 lb./month respectively in 1935. Most of the industry is situated in the north-west of England and between 1945 and 1947 the number of workers engaged in synthetic yarn production in this region rose from 6,700 to 12,710. On the manufacturing side, the labour force has expanded from 7,040 in 1945 to 27,560 in 1950. If supplies of raw materials, particularly sulphur, can be maintained, this virile new industry can do much to relieve the situation created by the shortage and high cost of natural fibres. More than 70 mills in this region are now spinning rayon staple in volume equal to 11% of the country's production of cotton yarns. Seven of the major units producing rayon yarn and staple are situated in Lancashire, where development projects since 1947 have cost more than £1,000,000 for buildings alone.

In the field of synthetic fibres generally two of the most important post-war results of the intensive research being carried out in Manchester and other parts of the region are the materials *Ardil* and *Terylene*, which are now in production by Imperial Chemical Industries Ltd. Other results are seen in the industry's ability to produce 'tailor made' fibres for a variety of specific end uses, ranging from dental floss to high tenacity viscose yarns for tyre cords. Use-development organisations have been set up for the purpose of finding new and improved uses for synthetic fibres. Their job in association with the research chemists is to bridge the gap between commercial utilisation and scientific research and to ensure that the products of the industry are used to the best possible advantage.

Productivity in steel foundries

INFORMATION gathered by the Productivity Committee of the British Steel Founders' Association from the Association's members shows that even where equipment was satisfactory improvements in productivity have still been possible. How productivity has been increased is outlined in a recently published report which, besides reviewing progress in the British steel-founding industry between 1948 and 1951, examines the effects on productivity of the report of the Steel Founding Productivity Team which visited U.S.A. in 1949.

Improvements in factory layout have increased productivity and many important changes have taken place, ranging from the installation by some firms of new melting shops or new bays to a general emphasis on better mechanised mouldings, whether by moulding machines or sandslingers, and on improved efficiency and conditions in fettling shops. It is clear that greater attention is being paid to those principles of layout which have been long known and which the Productivity Report was by no means the first to emphasise.

Nearly all founders mention the installation of new equipment or the better use of existing plant over the last three years, despite the fact that many had already carried out extensive schemes of improvement and modernisation. Many others tell of the installation of a wide range of new equipment with better control or servicing facilities. However, of all the steel-founding processes, steel melting has been least affected by the prevalent re-equipment trends. This may be due to a shortage of electric power, which makes the

installation of electric arc furnaces impracticable. Also, the scarcity of scrap has prevented a general turnover from basic to acid melting.

In the research field methods to speed operations include the use of acid arc melting, combined with carbometer testing and oxygen blow, which has reduced melting time by about 40% tap to tap. One way to produce better steel and cut down waste is by a reduction of refractory costs through better inspection, which often includes gamma-ray and magnetic crack detection, and by closest control of methods, sometimes through special new methods departments and development sections.

Standardisation is being increasingly emphasised and some sections of the B.S.F.A. have succeeded in standardising certain castings, while one founder, by offering good deliveries for standard patterns and poor deliveries for fancy modifications, has succeeded in having standard designs accepted.

Improved working conditions and increased amenities throughout the industry would not be effective without improved personal relations. This is being achieved by schemes for apprentices, older entrants and supervisory staff as well as publicity on the shop floor through the issue of productivity statistics and shop achievements. Also, more care is being taken to keep skilled men in skilled work and to service them efficiently.

Although there is as yet little evidence that the trade unions or employers' associations are acting on the Productivity Team's suggestions, the British Steel Founders' Association is now represented on the Foundry Committee of the Engineering and Allied Employers' Federation, and it is hoped thereby that action along lines set out will be encouraged.

New standard for calcium carbide

TOWARDS the end of the 1939-45 war it became evident that the methods of sampling and the methods for the determination of gas yield, purity of acetylene and impurities required to be brought up to date. Accordingly, the technical committee concerned with the preparation of the original standard recommended its revision.

The standard was originally published as a result of an agreement between the British Standards Institution and the British Acetylene Association to co-operate in the preparation and establishment of a British Standard for calcium carbide based upon the standards, conditions of sale and purchase, and the trade usages in the industry existing at that time.

The revised standard for calcium carbide (graded sizes), B.S. 642: 1951, covers eight sizes of grading. Test requirements for dust, gas yield and impurities are stated and methods of sampling and testing are specified. Conditions of sale and purchase as established by the British Acetylene Association are also given in Appendix B.

The main alterations in the revised standard are to be found in Appendix A, in which new apparatus and improved methods for the determination of gas yield and impurities have been included. The specification section now stipulates that the carbide shall yield gas containing not less than 99% by volume of acetylene, instead of 96% as in the original standard. Limits for arsenic and nitrogen compounds have been added to those for sulphur and phosphorus. Appendix B remains unaltered, except that the amounts of gas yield below which claims and rights of refusal are allowed have been slightly increased for all sizes below 15 mm. to accord with the tolerance of −5% specified in Clause 5.

During the preparation of the original standard, the committee had the advantages of the views and co-operation of the Dominion interests concerned, as well as the close collaboration of the associated European manufacturers of carbide. This close co-operation has been continued during the present revision.

Copies of this standard (4s. post free) may be obtained from the British Standards Institution, 24 Victoria Street, London, S.W.1.

A century of valency

'WHEN the formulae of inorganic chemical compounds are considered, even a superficial observer is struck with the general symmetry of their construction; the compounds of nitrogen, phosphorus, antimony and arsenic especially exhibit the tendency of these elements to form compounds containing three or five equivalents of other elements, and it is in these proportions that their affinities are best satisfied; thus in the ternal group we have NO_3, NH_3, NI_3, NS_3, PO_3, PH_3, PCl_3, SbO_3, SbH_3, $SbCl_3$, AsO_3, AsH_3, $AsCl_3$, etc.; and in the five-atom group NO_5, NH_4O, NH_4I, PO_5, PH_4I, etc. Without offering any hypothesis regarding the cause of this symmetrical grouping of atoms, it is sufficiently evident, from the examples just given, that such a tendency or law prevails, and that, no matter what the character of the uniting atoms may be, the combining power of the attracting elements, if I may be allowed the term, is always satisfied by the same number of these atoms.'

When these words, written by Dr. E. Frankland, were read to the Royal Society a hundred years ago, on June 17, 1852, he thought that they might lead ' to extensive modifications of our views respecting chemical compounds in general.' They did. He had introduced the idea that eventually became known as valency, and gave the first view of the order and system that runs through all chemical compounds.

Frankland himself started into the scientific world in the same unassuming way. He was born on January 25, 1825, and attended first a village school, and then Lancaster Grammar School. The latter had several practices that have since disappeared from education; the sixth form boys were entitled to solicit money from the bridegrooms at local marriages, for instance, and the school prizes were awarded as the result of a raffle. Leaving school, Frankland was apprenticed to a druggist, ' from which I derived no advantage whatever except the facility of tying up parcels neatly.' Actually his predecessor and successor as junior apprentice were Robert Galloway and George Maule, both to become distinguished chemists, so that he may have been a little unjust.

In 1845 Frankland went to London and, after a short time, to Marburg to work with Kolbe under Bunsen. From then on his life was successful, although arduous. He met Fräulein Fick, eventually to become his first wife, and then taught for a while at Queenwood School, where he met John Tyndall. Later he went to work under Liebig at Giessen, probably the most famous of all Continental chemical laboratories, and then in 1851 he was appointed the first Professor of Chemistry at the new Owens College in Manchester. It was from here that he sent his epoch-making suggestion to the Royal Society. Incidentally, the sentences quoted were actually part of the appendix to a paper on ' A New Series of Organic Bodies Containing Metals.'

Frankland was created a K.C.B. in 1897, one only of a large number of British and foreign distinctions. He died on August 9, 1899, shortly after the death of his second wife.

FILTRATION

Fundamentals, equipment, filter aids and media, and applications

By E. L. Streatfield, B.Sc., F.R.I.C., M.I.Chem.E.

WHILE this review nominally covers the preceding 12 months, a number of earlier references have been included in some instances for the sake of completeness. The subject of this review is conventional filtration, *i.e.* the separation of undissolved solids from liquids by methods other than centrifuging, sedimentation and adsorption.

When considering the theory of filtration it is important to refer to the third edition, published in 1950, of Perry's 'Chemical Engineer's Handbook,' in which the section on filtration,[1] while not including the most recent advances in theory, nevertheless contains a most useful summary of theoretical and empirical equations. Furthermore, the material on filter media has been brought up to date and some new filters are described. Theoretical aspects of filtration are also covered in an excellent chapter on filtration[2] in the new textbook on unit operations. The greater part of the chapter is devoted to mathematical correlating relationships which include not only the conventional Poiseuille-Darcy constant-pressure and constant-rate equations expressed in terms of cake porosity, but also the Brownell-Katz approach from the standpoint of a modified Fanning group, including particle and cake characteristics. This approach is prepared for in the two preceding chapters[3] devoted to the Brownell-Katz method. Fifteen problems are cited at the end of the chapter to illustrate filter design calculations. There is also an extensive theoretical review and analysis of filtration problems presented[4] in a new reference book of organic chemical technique. It should also be mentioned that Miller[5] has reviewed very fully in the American literature, with 151 references, papers published 1949-50 dealing with filtration equipment and its industrial applications, filter aids and media, etc.

Advances in filtration theory are reviewed in a recent paper by Miller,[6] who discusses the basic difference in both mechanism and theory between the filter cake and filter medium types of filtration. This basic difference is important in the practical application of commercial filters, since most units are best suited to either cake filtration or medium filtration, while only a few must be considered for both types of operation.

[*Photo: Cannon Iron Foundries Ltd.*

A steam-jacketed gravity filter for handling strong concentrated solutions of salts, sodium sulphate, copper sulphate, etc. It is of robust cast-iron construction and lined throughout with hard grey acid-resisting glass enamel. It is constructed in two steam-jacketed hinged sections, suitable for steam up to 40 lb./sq.in., with perforated plate. The top and bottom inner sections are identical, giving advantage for spares or replacements. The inlet in the upper section and the outlet in the lower section are suitable for flanged connections. The two jacketed sections are secured by Lindaptors, ensuring easy release. The filter is made in two standard sizes with effective plate diameters of 8 in. and 20 in. and may be supplied without steam jackets, if required.

Experimental data and design

Grace,[7] in a recent paper, discusses the factors governing the selection of the best filter for either cake filtration or medium filtration and compares the advantages and disadvantages of each type. In cake filtration, where the purpose may be the recovery of the cake solids or of the filtrate, or of both, the filter cycle is controlled largely by the resistance characteristics of the cake solids and the selection between pressure and vacuum operation depends largely on quantitative determination of the filtration characteristics by laboratory methods. In medium filtration, where the purpose is limited to recovery of a clarified liquid, the particle removal occurs largely by entrapment within the filter medium or bed. The size of particle to be removed and degree of particle removal required are important in filter selection, since performance depends largely on the filter medium or bed used and not on formation of a filter cake.

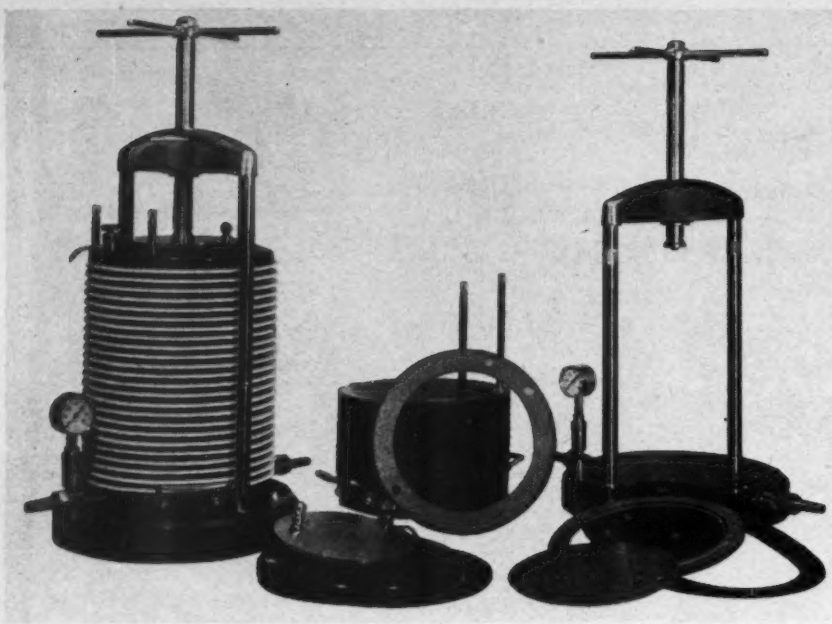
Jones[8] has correlated performance and laboratory filter tests for rotary vacuum filters. The yield of filtrate obtained during vacuum filtration is directly proportional to the filtering area and to the square root of the drop in pressure across the cake. It is possible to calculate the capacity of a rotary vacuum filter and also to determine the optimum operating conditions.

Furmeister[9] discusses the physical and chemical conditions which affect filtration rates, *e.g.* temperature, slurry density, viscosity, particle size, etc., with experimental data, and describes mechanical means of handling slurries which are claimed to improve filtration results.

Although in this review there is a section dealing with water filtration, it is appropriate to refer in the present section to a paper by Fair,[10] in which he discusses the hydraulics of rapid sand filters. To do this, he considers six elements of a sand filter, *viz.* the sand bed, the supporting gravel layer, the underdrainage system, the scouring system, the wash water collecting system and the ancillary conduits and appurtenances. Fair calculates not only the loss of head through each of these six elements for different rates of flow, but also the required depth of filter bed in relation to grain size and the expansion of the bed by back-washing.

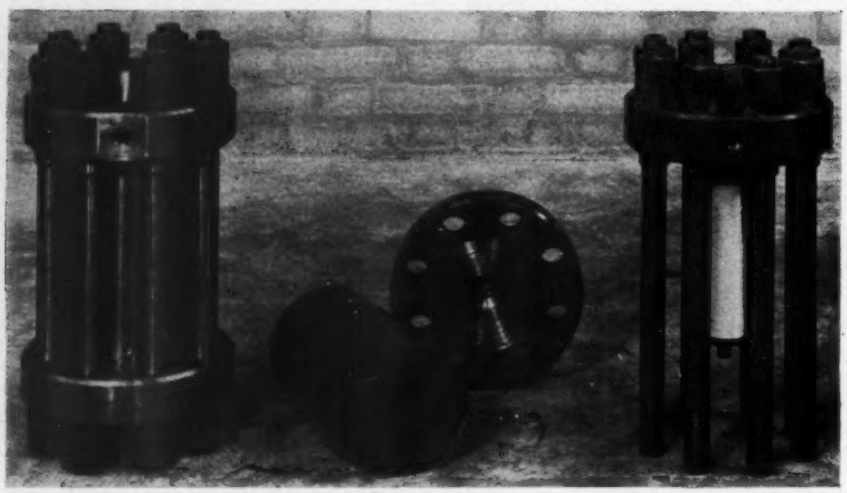
Equipment

The literature contains a number of interesting references to inventions claiming improvements in design of filters and equipment. For instance, there are several patent specifications in which self-cleaning filters are described. In one[11] the filter medium is held under tension on a helical spring in a closed vessel and the accumulated solids deposited from the treated liquids are ejected by a combined vibratory, relaxing and stretching movement of the filter. A filter unit[12] is described for cleaning fluids used in dry-cleaning plants, the filter being provided with self-cleaning



[*Photo: British Filters Ltd*

A filter press developed over the last two years for the plating trade and designed particularly for the filtration of corrosive liquids. The filter plates receive filtrate from both sides through two perforated plastic sheets, supported against pressure by spacing studs. The plates can be readily dismantled for cleaning. The filter pack and base plate, which are fully machined, are constructed in an asbestos-filled thermosetting plastic, possessing high-temperature and chemical resistance, low moisture absorption and high tensile and impact strength. The framework and fittings are highly finished in stainless steel. The complete filter pack can be removed *en bloc* from the framework to facilitate servicing and assembly. The filter is available as either a plate and frame, or chambered plate unit with a maximum filtering area of approximately 10 sq. ft. Rubber sealing gaskets of special design can be supplied for use with filtering media which will not, of themselves, form a seal between the plates. A special transfer plate is available for two-stage filtration. Fittings can be supplied in ebonite or other materials to special order. The maximum working pressure amounts to 50 lb./sq.in.



[*Photo: Aerox Ltd.*

A complete porous ceramic filter suitable for air, gases and liquids. This particular model is being used for the filtration of nitrogen in the manufacture of expanded rubber. Aerox filters, of which there are six standard sizes, all use 'Porsilex' porous ceramic elements and are available for pressures up to 5,000 lb./sq.in. Six grades of 'Porsilex' media provide pore sizes of 5 to 5.5, 10 to 12, 20 to 22, 50 to 60, 100 to 120 and 160 to 200 microns, thus giving a wide choice for different applications. The design of this filter is covered by British Patent 652931 (May 1951). A modified design has a number of undercut skirts on the filter element which assist in carrying away moisture, foreign matter or impurities which have been separated from the air or gas.

means by oscillating the cloths within the filter tanks. In a further invention[13] the apparatus is rapidly cleaned by the use of compressed air, stored in a portion of the filter housing, to force water with high velocity back through the filter elements. Automatic filter cleaning is also described[14] and also improved means of cleaning manually.[15, 16]

Rotary drum filters are the subject of a number of patents. The Komline-Sanderson Eng. Corp. describe[17] a filter in which a cord-strand filter web passes from the drum over a discharge roller, and then over two rollers which enable the strands to be separated and washed before being returned to the drum. In a later patent specification[18] the same people attempt to overcome disadvantages inherent in the use of textile cords as the filter medium for rotary drum filters by using closely coiled metal tension spring filaments. The use of a filter surface composed of strings arranged on the filter drum in a special formation is also described.[19] Several improvements in the construction of rotary drum filters are also claimed in patent specifications, *viz.*, the mounting of filter cloths on longitudinal panels;[20] the prevention of the suction acting when discharging the filter cake;[21] the structure surrounding the drum;[22] the construction of a rotary filter having several sections which may be successfully connected to suction pressure or atmosphere;[23] the arrangement of heat exchange elements to supply the heating or cooling medium;[24] and design of filter plates.[25]

As might be expected there have been many inventions to improve the arrangement or design of filter elements. Filter elements of the edge filtration type include one[26] of plastic material that is self-supporting and, therefore, does not require a supporting frame, while others describe means of supporting the filter elements.[27,28] Typical of these is a filter[29] in which a central perforated tube supports alternate annular filter and spacing elements, the latter having their inner and outer edges thickened in order to provide a gap for the passage of the liquid. The inner and outer edges of the spacers are formed with teeth, the spaces in between forming the liquid passages.

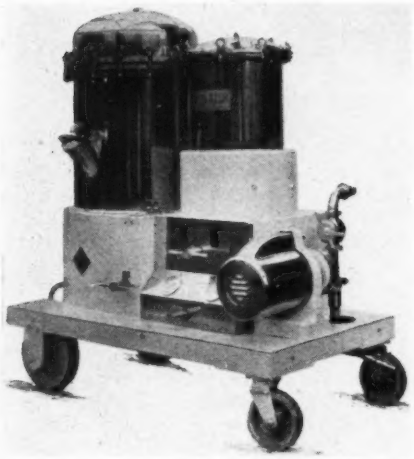
A number of metallic filter elements are described in the patent literature. For example, a filter[30] with a sintered bronze element suitable for liquids and gases; elements[31] consisting of a gauze cylinder covered with fibres, the ends of the cylinders being turned inwards leaving a slide into which a perforated outlet pipe fits; a filter[32] the body of which contains a number of straight grooves in which are fitted filler members in the form of rods or cords. Also described[33] is a filter using elements each of which is in the form of an airfoil section, the front being made impervious to the liquid. In this way a filter offering only a low resistance to the fluid may be built. There is also a leaf filter

unit[34] consisting of two perforated frusto-conical annuli pressed together base to base. Each of these supports on their internal surfaces a fine wire gauze and porous filter medium. Inventions also include a cartridge element[35] with a settling trap in its core for collection of heavy suspended particles; a metallic element[36] for supporting filter paper; and concentric braided metal tubes[37] containing a filling of fibrous material, *e.g.* glass wool.

Applications

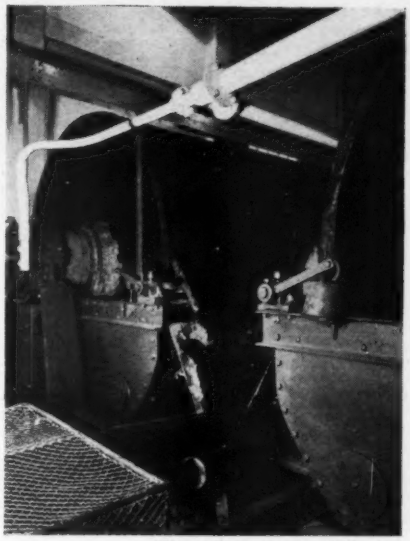
Claude[38] has described the vertical leaf precoat pressure filter and has discussed its use in American plants for filtering water, oil, varnish and general chemicals. Woolf and Bethune[39] have given a detailed description of the Burt filter (a rotating batch pressure filter) and its use in zinc leaching. The operation and application of the Waco filter, a rotary gravity filter in the paper-making industry, is described by Perkins.[40] The filter is covered with a travelling wire cloth. A thin filter medium, generally wood pulp, is formed in advance on the wire before it enters the liquid to be filtered, and thus no influent passes through the bare wire. Improvements in the filtration of viscous solutions which tend to clog the pores of ordinary filters are described in a patent specification.[41] The viscous solutions can be clarified in filters with layers of an inorganic salt which is insoluble in the viscous solution but soluble in water. The filter layer is supported by a porous mineral bed, *e.g.* alundum, and periodic backwashing with water at a suitable temperature reconditions the filter layer by dissolving the crystals. Fresh crystals may then be added or may be formed inside the filter unit.

Apparatus for feeding filter aid, *e.g.* diatomaceous earth, is described[42] in a patent specification. The filter aid is fed to a filter by supporting it on a wire mesh screen (with a central deflecting disc) located near the bottom of a closed chamber. Part of the liquid to be filtered is by-passed and directed against the disc so as to erode the body of filter aid. The liquid containing suspended filter aid is



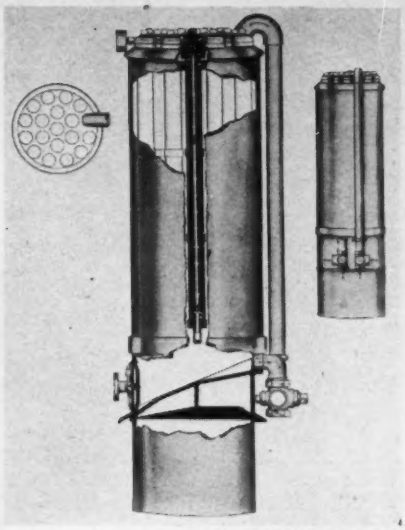
[*Photo: The Metafiltration Co. Ltd.*

A 100 to 200 barrel hr. beer filter constructed entirely in stainless steel. It is quite self-contained, with its own pump, injector, circulating and cleaning arrangements. It is not a variant of the general Metafilter design, but its operation has been simplified. In particular, cleaning is efficiently accomplished in a minute or two. These units are suitable for the whole filtration requirements of a brewery, being adapted both for filtration of rough beer and polishing. They also undertake the filtration of tank bottoms if required, and the same filter can be employed for sterilising—it is merely necessary to employ a different grade of filtering media. These filters also have many uses in the chemical industry where a perfectly clear, brilliant liquid is required. They are available in any metal which may be necessitated by the chemical nature of the process.



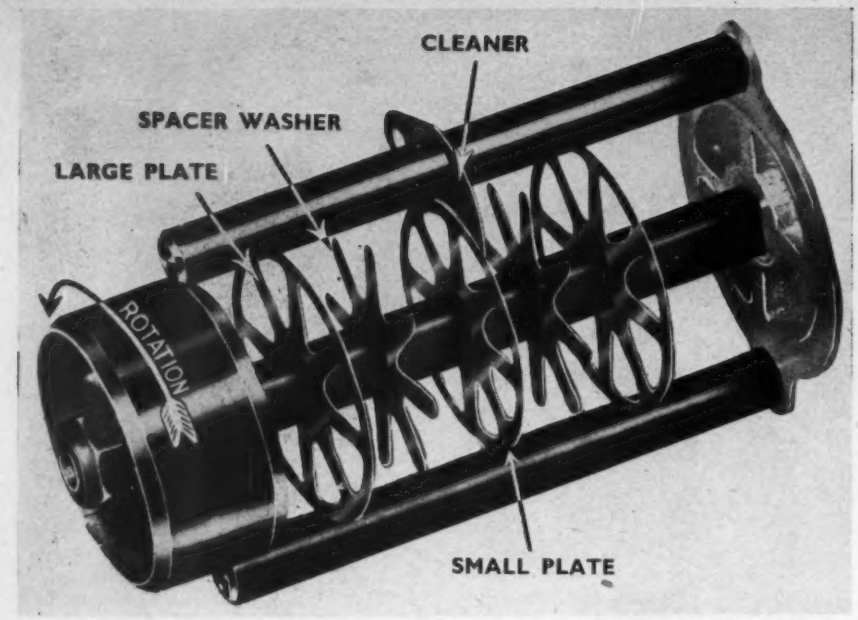
[*Photo: Davey, Paxman & Co. Ltd.*

A 200 to 300 sq. ft. rotary vacuum filter plant for chemical, metallurgical and general filtration processes. Designed for the normal requirements of the chemical and allied industries, Paxman filters with cast-iron, mild steel or stainless-steel drums, alternatively lined with rubber or similar material, are manufactured in standard sizes, each being specially constructed to meet the particular purpose for which it is intended. The filter consists of a drum divided into a number of self-contained vacuum- and pressure-type cells or compartments, which are an integral part of the whole drum and communicate with ports in a valve head. The drum is clothed with a suitable filtering medium such as gauze, filter cloth, etc. The valve head is divided into three sections, which give control of the suctions and blow-back air. The material to be treated is generally pumped into a trough, in which the drum is partially submerged and rotating at a speed of about 1 r.p.m. The application of a vacuum to the cells causes the solids in the material to be drawn against the filtering medium on the periphery of the drum, while the liquid passes through the medium into the cells and through to the valve head and run-off pipes. The vacuum continues to be applied to the cells as they leave the submerged portion of the trough, with the result that the moisture is drawn off, leaving a reasonably dry cake which is taken off by scraper knife, or doctor roll, assisted where necessary by a slight air pressure applied through the cells to the underside of the cake. The process is continuous and many include washing of the filter cake if necessary. These filters are capable of continuous operation for almost indefinite periods and require practically no attention other than normal lubrication and usual supervision at intervals of the filter cloth or other filter medium. Only unskilled supervision is required. Power consumption is low.



[*Photo: Doulton & Co. Ltd.*

High-pressure industrial filter designed (a) to provide a large capacity unit, suitable for running at high pressures; (b) to reduce to a minimum the time required for cleaning and maintenance; and (c) to allow easy cleansing by back-flushing, adequate space for thick cake-build-up and heavy sludge accumulation, and to provide for easy removal of the accumulated sludge. The unit comprises 54 porous candles, 10 in. × 2 in., in banks of three on 18 perforated tube fittings. Each perforated tube can be removed through the top plate by slackening off two nuts. Adequate sealing is achieved when these nuts are thumb tight or, at most, tightened up with a tommy bar. The three elements on a fitting can be brushed clean without removing them from the perforated tube and can be replaced immediately in position. External piping and valves provide for back-flushing where this method of cleaning is adopted. The bottom of the unit slopes towards a sludge door which is removed by the turn of a hand wheel, and which is large enough to allow an arm to reach inside the casing. A pressure gauge is fitted on to the outlet chamber on the top front of the unit and will indicate when cleansing is advisable or give immediate warning of any failure. Air vents are provided for bleeding away any air trapped in the unit. The number of 10-in. elements in the unit can be adjusted to multiples of 18 by increasing or decreasing the length of the perforated tube fittings and the length of the steel tube between top and bottom castings. For water filtration for breweries, mineral water and similar works, the unit is supplied with top and bottom castings of best quality gunmetal, all parts being hot-tinned or galvanised as a protective finish. It is anticipated that the unit will also be produced in the near future in stainless steel and other materials to enable it to be used where corrosive liquids are being processed. For water filtration this unit is usually fitted with Doulton kieselguhr candles (normal porosity), but it can also be fitted with other grades.



[*Photo: Auto-Klean Strainers Ltd.*

A large Auto-Klean T.K. strainer in which the strainer element is made up of a number of metal plates with a washer between each. The gauge of the washer determines the degree of filtration. Two sizes of plates are used, the outside diameter of the smaller being equal to the inside diameter of the rim of the larger. Between the rims of the larger plates there is a very strong cleaner blade, the toe of which rests on the outside edge of the smaller plate and overlaps the straining mesh. The liquid being strained, passes through the narrow slots at the edges of the plates, flowing from the outside of the element to the inside and depositing solid matter on the edges of the plates; by turning a handle at the top of the strainer either manually or mechanically the plates are revolved against the fixed cleaner blades and the solid matter is removed from the element and deposited in the sump. The strainers can be supplied with elements of 1.5 in., 3.15 in. and 5.7 in. diameter of meshes down to .001 in. (25 microns). They can be used for filtering water, chemicals, paints and enamels, food products, and lubricating and fuel oils. The internal components of the strainer are made in steel, stainless steel, phosphor bronze, Monel metal or brass as required.

then returned to the flow line. There is also a patent[43] covering apparatus for forming a filter cake on a filter body, by a succession of thin layers of cake built up on the surface of a rotating filter drum by means of sets of atomisers grouped round the drum.

The precoating of filters is the subject of an invention,[44] whereby a small amount of caustic soda is added to a suspension of kieselguhr in a hydrocarbon oil, to maintain a uniform dispersion for use as a filter precoat.

Filter aids and media. Diatomaceous earth still appears to be the filter aid most widely used and little has appeared recently in the literature to add to earlier knowledge. Robertson[87] has given, however, a very useful summary of the production, properties and applications of diatomaceous earth as a filter aid, in a recent article. A recent invention[45] describes the decolouring of sugar syrups by uncalcined diatomaceous earth supported on the surface of fine coke particles (10 to 60 mesh). This is said to allow comparatively rapid and effective filtration of syrups of around 50° Brix.

An important survey of the present knowledge of fabric filter media is provided in a paper[46] by Smith in which he deals with the physical properties of fabric filter media, their relation to difficulties encountered in filtration operations, together with a description of the chief causes of these difficulties. Smith reviews the fibres normally used for filter fabrics and also discusses new types of fabric such as nylon, *Orlon*, *Vinyon* and *Saran* and their physical properties. These synthetic fibres are becoming increasingly popular because of their high mechanical strength and resistance to corrosion.

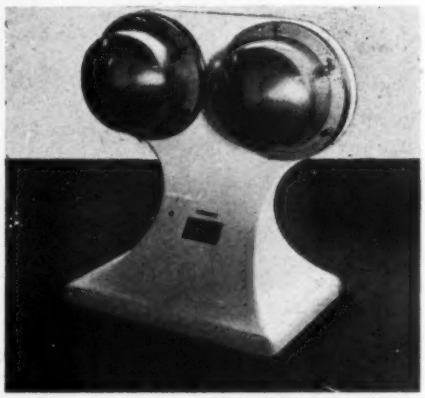
There are also references in the patent literature to filter media inventions. Thus, a strainer cloth[47] for use in filter presses, especially those employed in the preparation of potter's clay, is formed by backing fine nylon fabric, fine linen or similar woven material with an open-mesh fabric, *e.g.* hessian or woven polyvinyl chloride, to impart rigidity. Edge-filtration pads for removing oil from condensate from turbines of sea-going vessels are described.[48] Crepe layers are impregnated with a water-soluble phenolic resin, which has been rendered insoluble by polymerisation, and are then held pressed together by a spring. The outer surface is then coated with a thin layer of granular material (fuller's earth, clay, magnesium silicate, etc.) and the resulting packs are placed in a cylindrical metal filter chamber, and are used in successive filters, through which oil-contaminated condensate passes and is demulsified.

Water, sewage and industrial wastes

In a recently published book on water treatment Nordell[49] devotes part of a chapter dealing with the clarification of water to giving some useful data on the design and operation of pressure and rapid gravity filters.

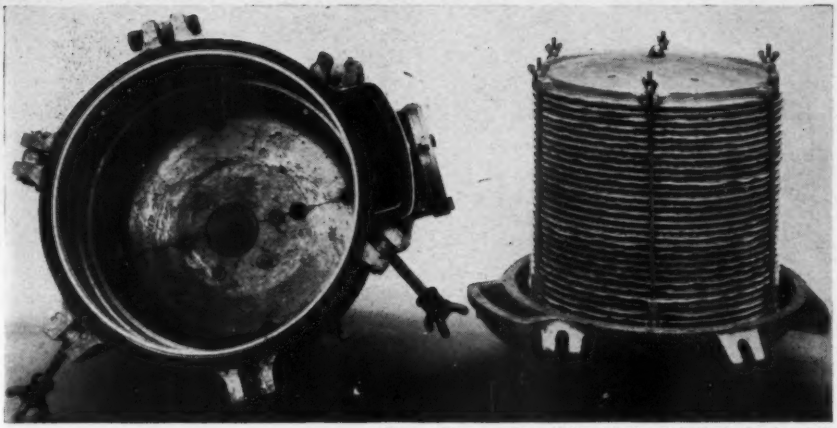
For water filtration, sand filters continue to be the most popular, although graded anthracite is being increasingly used. Experience with high rate filtration in the operation of sand filters, *i.e.* rates in excess of 2 gal./sq.ft./min., have been reported by Baylis and others.[50, 51] The chief objection to high rate filtration is the possible reduction in the bacteriological quality of the effluent, but some experiments have shown that the rate of filtration has little effect on the quality of the effluent if pretreatment of the water is satisfactory.

Sand and anthracite are compared as filter media by Rubinov,[52] who also discusses methods of improving distribution of water and backwashing of the filters. Tankard[53] has summarised difficulties encountered in (but not necessarily peculiar to) pressure filter operation due to heavy algal growths in the filter beds. The filter medium was anthracite.



[*Photo: Cherry-Burrell Ltd.*

A new disc-type fluid filter which has a wide application in the liquid food processing industry or, in fact, wherever a cloth provides the actual filtering medium. The design is such that practically the whole surface of the cloth is used and the method of feed creates a slight turbulence in the liquid, thereby enabling the cloth to filter better by keeping foreign matter in suspension and eliminating local build-up during operation. At the same time the cloth is subjected to an even pressure over its complete area and therefore retains its original form and weave, which in turn increases its life. Factory tests have shown that, with normal operation, a 50% saving of filter cloths is obtainable. For example, in one typical test, a 2,000-gal./hr. unit of this type filtered 17,000 gal. with only one cloth change. The units are built in a capacity range from 400 to 2,000 gal./hr. and are available as single equipment or in a duplex arrangement. Each unit can be adapted to handle an increased volume merely by the addition of a number of filter discs.



[*Photo: Thompson Bros. (Bilston) Ltd. and Rellumit (London) Ltd.*

A 200-gal./min. 'Rellumit' static micro-filter for filtering petrol, diesel oil and other liquid fuels. It has two important features: (a) the filter pack with multiple plates provides the maximum filtering surface for a given volume and (b) the shape is designed to assist the effect of gravity in removing dust and particles. The element of the filter consists of a pack of 35 plates. Between each plate are inserted nylon and paper discs through which filtration takes place. The liquid penetrates into the filter pack by the holes placed on the outside circumference of the plate, passes through the paper and nylon, and the impurities contained are left on the lower surface of the filter elements (paper). The liquid is then forced through the apertures of the inside periphery of the plates through the perforated tube and directed into the outlet chamber which supports the pack. The passage of the liquid from the lower to the upper part prevents the impurities from immediately clogging the filter and, furthermore, the dish formed by the plate constitutes a secondary separator chamber. The filter has an efficiency of 98.5% and will remove 75% of 1 micron particles and 23.5% particles between 1 and 4 microns. It is, therefore, a 4 microns filter. On the other hand, it is possible to get 99.9% filtration by increasing the layers of paper. The initial pressure drop of the filter on petrol with a 4 micron paper, at 200 gal./min., is 3.5 lb./sq.in. and the maximum pressure drop allowed 25 lb./sq.in. It is understood that for fuel having a much higher viscosity than petrol the initial pressure drop will be higher.

[*Photo: John C. Carlson Ltd.*

The Ariston Princess filter mounted on a compact tubular steel stand with a pump beneath the filter, the whole unit being easily movable. This model is operated with 40-cm. asbestos filter sheets, up to 24 of which may be fitted, according to the output required. The fluid viscosity and applied pressure also affect the output, which ranges between 4 and 400 gal./day. The tightening spindle is held in position by a movable bridge piece, and a hydraulic closing device may be added if desired. The filter is equally suitable for clarifying or sterilising filtration and, if required, may be equipped with a change-over plate to enable both preliminary and polishing or sterilising filtration to be carried out in one operation. It is particularly suitable for the filtration of wines, spirits and liqueurs which are ready for bottling. The bottling of wines containing carbon dioxide, not generally a simple matter, can be carried out without difficulty through this filter, and with full retention of the gas in the wine. By appropriate choice of sheets, it can be used to sterilise air, blood plasma and antitoxin solutions, etc. Construction is of an aluminium alloy with a special non-corrosive finish, and heavily silver plated phosphor bronze connections.

Operating experience of a general character relating to filter plants has been described and these papers add to the history of this subject.[54, 55, 56, 57, 58, 59, 60]

Experiments in iron and manganese removal at a new filtration plant are described by Carey and Mawson.[61]

An excellent account of the applications of micro-straining in water treatment has been given by Boucher,[62] together with experiences at a number of installations.

There are also several references in the literature to filter media and aids for water filtration. The properties of porcelain filter candles, their uses for disinfection of liquids and as filters in industrial processes and in the laboratory are discussed.[63] Heath[64] describes the use of diatomaceous earth filtration in swimming bath purification and the preparation of a porous filter powder for use in the treatment of water is described[65] in a patent specification.

There have been several papers dealing with sewage treatment and the effects on such treatment of industrial waste effluents, in which filtration studies have played a considerable part. A review of the subject has been given by Rudolfs and others,[66] and studies in the mechanical filtration of sewage effluents have been described in a Water Pollution Research Report.[67] Studies with high and low rate filters in sewage treatment have been described by Cunningham,[68] and a comparison of the results obtained in the mechanical filtration of sewage effluents through sand and anthracite at various flow rates have been described by Pettet and others.[69] Heynike and Westhof[70] describe investigations of the rapid sand filtration of humus tank effluent without the use of coagulants.

There are a number of reports[71, 72, 73, 74, 75] on trickling filter studies and biofiltration plant studies are described by Moore and others[76] and by Tredgett.[77]

Factors affecting the vacuum filtration of sewage sludge are described by Komline,[78] and Szymanski[79] describes the incineration of filter cake obtained by vacuum filtration.

Filtration is important in the treatment of a number of industrial waste effluents. Calise,[80] in dealing with economic factors in waste water treatment, describes how an upward flow *Calcite* filter may be used to neutralise small amounts of settled acid waste waters and he also describes the removal of oil from waste waters from an oil refinery by coagulation, followed by filtration through anthracite. Biological filtration is used in the treatment of waste waters containing many chemical substances, *e.g.* picric acid and dinitrophenol;[81] and formaldehyde.[82] Diverse applications of biological filtration which have been reported include the treatment of gas liquor[83] and meat wastes.[84]

The paper-making industry's problem of recovering fibre from white water, eliminating stream pollution and minimising water make-up can be reduced by clarification of white water by sedimentation, flotation or filtration and these three tech-

niques have been compared and discussed.[85, 86]

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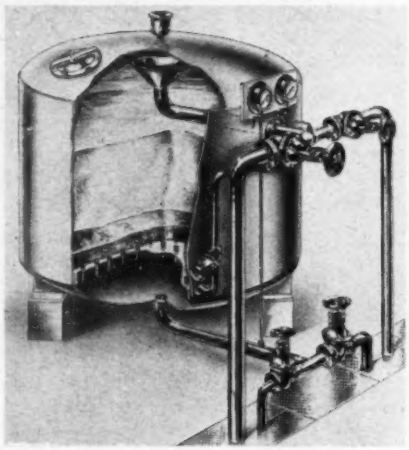
[Photo: Hathernware Ltd.

A white stoneware filter tank with an inside size of 7 ft. × 5 ft., and a depth over the filter tiles of 1 ft. 9in. This is one of the largest sizes of tanks made in one piece in chemical stoneware, the walls being about 2 in. thick and stiffened with a top rim. The tank is designed for embedding in a casing of brickwork and, for this purpose, a bottom outlet is provided with a ground-in pipe to protrude through the casing, which is strongly constructed of acid-resisting blue bricks on a concrete foundation. The bottom of the tank slopes towards the outlet pipe, both from the back and from the two sides. Four integral ribs formed in the bottom are arched for efficient drainage and support the false bottom made up of rows of filter tiles. The filter tiles are grooved and perforated, each 12-in. square tile being cut obliquely to make two pieces, each piece resting on a three-point ground-face bearing surface to ensure firm seating. The edges of the tiles are also ground to give close-fitting rows. The filter tiles, which are 2 in. thick, are sufficiently strong to bear the weight of a man for fitting and cleaning purposes. The tiles and the inside of the tank are covered with a bright white glaze, smooth and leadless, ensuring cleanliness in use.



[Photo: Filtrators Ltd.

Standard vertical pressure filter used for the filtration of water in public supply and for process work, employing as the filter medium, graded sand or anthracite, or activated carbon for the removal of taste and odour in the water. The filter, which may have an output of up to 5,000 to 6,000 gal./hr., is cleansed by air agitation followed by backwashing.

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Recent publications

Finned tube for heat transmission plant. Specially written and compiled for all engineers concerned with the use of finned tube heat transmission plant, including air heaters and coolers, unit heaters and coolers, engine coolers, compressed air coolers, oil coolers and refrigerating equipment, etc., 'Finned Tube,' published by The Spiral Tube and Components Co., Ltd., attempts to fill the gap in the literature on industrial plant which incorporates finned tube heat-transmission units. Spiral tube was introduced in this country over 45 years ago, but it is only during the last 25 years that considerable developments have occurred in the design of finned tube heat-transmission units, and in their adoption for many varied duties. Twenty-three pages are devoted to heat transfer theory with a note on the significance of finned tube. Thirty-eight pages describe the applications of finned tube. A comprehensive 52-page section of tables completes this admirable contribution to the literature of heat engineering.

Metal equipment. 'Dexion News' is a well-produced little booklet which describes new uses for *Dexion* slotted-angle constructional material. Storage racks, step ladders, machine guards, conveyors and trolleys are among the equipment built with this versatile material and described in this booklet, which is issued by Dexion Ltd.

Chemical and Engineering Problems of the Gas Industry

The wide range of technical and scientific interests of the British gas industry was strikingly demonstrated at the research meeting of the Institute of Gas Engineers and the Gas Research Board held in London last November. Eleven papers and five reports of technical sub-committees were read during the two-day meeting. Ten of these papers are summarised below. The subjects of these papers include: recovery of sulphur, treatment of effluent liquors, the gasification of carbon, and the design and development of special plant such as target impact gas burners, and high temperature furnaces.

Effluent liquor treatment

THE possibilities of using nitric acid and nitrous acid for the destruction of the residual toxic matter in ammonia still effluents, and other effluents from gas works were discussed by C. COOPER and W. E. BOUCH (W. C. Holmes & Co. Ltd.). The effect of the reactions is to destroy the inorganic salts such as thiosulphate and thiocyanate, the products of decomposition of nitric acid being largely recoverable for further employment, after the gases evolved have been oxidised with air. Consequently, the total effect is to accomplish the conversion of these salts to comparatively harmless substances by indirectly employing atmospheric oxygen.

Phenolic matter which is present combines with nitric acid, which is thereafter unrecoverable.

Nitric acid or nitrogen oxides for these purposes can be obtained by the catalytic conversion of ammonia.

The reactions employed are therefore as follows:

(1) $2\ NH_4CNS + 4\ HNO_3 = (NH_4)_2SO_4 + H_2SO_4 + 2\ HCN + 4\ NO.$

(2) $(NH_4)_2S_2O_3 + n\ HNO_3 \rightarrow (NH_4)_2SO_4 + H_2SO_4 + n\ NO.$

(3) $2\ NO + O_2 = N_2O_4 \rightarrow HNO_3 + HNO_2.$

(4) $2\ NH_3 + 2\tfrac{1}{2}O_2 = 2\ NO + 3\ H_2O.$

The presence of chlorides, which is almost universally to be expected, has important effects on the course of the reactions. Primarily, chloride reacts in a manner that assists the decomposition of the other ammonia salts, but reaction will persist between ammonium chloride and nitric acid in solution, if allowed, after the process has reached its desired conclusion.

Nitrated phenols will exist in treated solutions and may require removal. It is also indicated that, where solutions of thiocyanate of fairly high concentration are available, the possibility exists of a remunerative recovery of hydrocyanic acid.

The important matter of costs is also considered, in conjunction with the costs of previous dephenolation treatment, and the alternative costs of disposal of effluents of normal content of toxic substances. The authors have only rather vague ideas on the capital costs of the complete treatment unit, but with such guidance as is available on the extent of acid-proof plant for production of nitric acid, they are reasonably sure that a total capital charge of 5s. per 1,000 gal. will not be exceeded on the scale of treating 500 to 1,000 gal./hr. of effluent.

Filtration of gas works liquor

Three factors have recently brought the problem of gas works liquor disposal into greater prominence: first, increase in loads carried by sewage-treatment plants, which has decreased their reserves of purification capacity; second, increases in gas production and in centralisation of gas works, which in many districts have thrown out of balance the relation between amount of gas liquor and sewage flow; and, finally, the passing of new legislation on the prevention of pollution, which has led to the setting up of River Boards with powers to impose standards for effluents discharged to surface waters.

Research into the treatment of gas liquor in admixture with sewage in percolating filters and by the activated-sludge process has been carried out for a number of years by the Institution of Gas Engineers. Part of this work consisted of large-scale experiments of comparatively short duration on the treatment of known concentrations of gas liquor in percolating filters at the sewage disposal works at Leamington, and part was an investigation of the processes of biological oxidation and the effects of various constituents of gas liquor on the biological purification of sewage. Investigations extending this work were described by W. H. BLACKBURN (Gas Research Board) and T. G. TOMLINSON and T. H. SUMMERS (Water Pollution Research Laboratory). This work started in 1947 when the City Engineer of Coventry placed a small sewage-disposal works at Stivichall, comprising two circular percolating filters, at the disposal of the Water Pollution Research Laboratory for the purpose of carrying out experiments on the effect of known concentrations of gas liquor on the treatment of settled sewage of purely domestic origin.

Experiments were made on the effect of (*a*) spent gas liquor and (*b*) fractions of crude gas liquor on biological filtration of settled sewage.

The trials with spent gas liquor were made in two large-scale percolating filters. Addition of the liquor in a concentration of 0.5% by volume caused a significant deterioration in the chemical quality of the effluent and intensified the colour.

The trials with the fractions of crude liquor were made in small percolating filters, each 1 ft. in diameter. The greatest deterioration in the quality of the sewage effluent was caused by the addition of two fractions, one containing thiocyanate, ammonia and organic substances not extracted from the crude liquor by methyl isobutyl ketone, and the other containing carboxylic acids and 'humic acids.' Of the four fractions into which the phenols were divided, the two containing polyhydric phenols caused a significantly greater deterioration in the quality of the effluent (as measured by the test for oxygen absorbed from permanganate) than did the two containing monohydric phenols, but the effect of all four fractions on the biochemical oxygen demand of the effluent was very similar. The bearing of these results on the practice of hot gas de-tarring was discussed.

Sulphur from oxide plant

Pure sulphur may be recovered from ordinary gas works' spent oxide by extraction with toluene, if certain precautions are taken. F. A. BURDEN and W. B. S. NEWLING (North Thames Gas Board) described the process employed and the pilot plant they have developed.

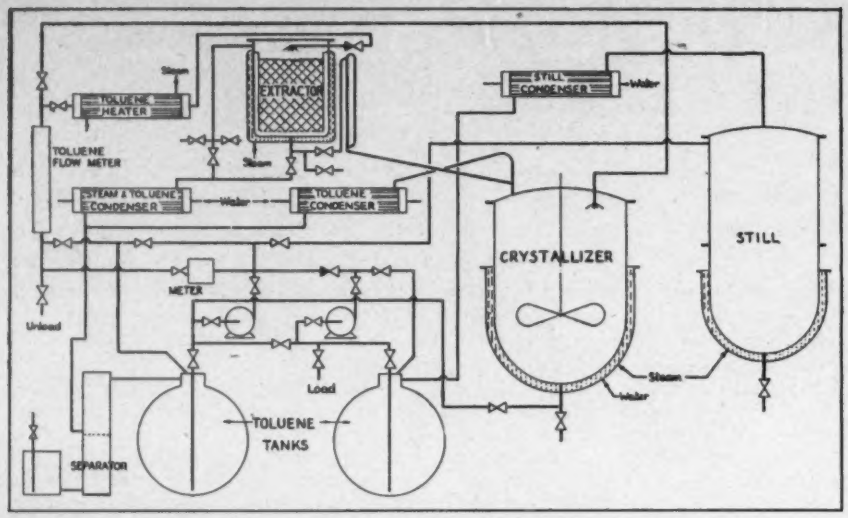
The design is for batch operation of each stage of the process; these stages are as follows:

(1) The oxide is dried in apparatus separate from the extraction plant. A batch of about 150 lb. of the dried oxide is brought to the plant in a cylindrical container with a filter-cloth base.

(2) The 'basket' of oxide is fitted into the extractor, which is an enclosed mild-steel vessel heated by a steam jacket to 105°C. and thermally insulated. The extractor is purged with nitrogen to remove the air.

(3) Toluene vapour is then passed into the extractor; it condenses on the oxide and heats it to the required temperature of 105°C.

(4) Liquid toluene at 105°C. is then passed into the extractor. This is so arranged that the oxide charge is covered



Simplified flowsheet of the pilot plant for the recovery of pure sulphur from ordinary gas works' spent oxide by extraction with toluene.

with toluene, which flows down through the charge. The sulphur solution passes through the filter cloth and away from the extractor by an overflow seal to the crystalliser. When the desired volume of solvent has been passed, the oxide is drained, either by gravity to the separator through the steam and toluene condenser, or by nitrogen pressure to the crystalliser.

(5) Crystallisation is effected in a cast-iron vessel, enamelled inside, steam-jacketed outside, and fitted with a stirrer. It is heated at 105°C. while receiving the extract solution. When the total of about 60 gal. of solution from one batch of oxide has been collected, the steam to the jacket is turned off, the stirrer is started, and cooling water is passed through the jacket at a controlled temperature.

(6) When the desired minimum crystallisation temperature is reached, the cooling water is turned off, the stirring is stopped, and the mother liquor is pumped from the crystals, which are retained by a gauze filter. The crystals are washed with cold toluene, which is quickly pumped away. The crystalliser jacket is again heated with steam to melt the sulphur crystals and raise the melt to 120°C., so that all toluene is distilled off. The melt, about 65 lb. of sulphur, is run off from the crystalliser vessel through a steam-jacketed cock into a special receiver.

(7) During the crystallisation period, the sulphur-free oxide in the extractor is treated with direct steam to remove residual toluene, the steam and toluene vapour passing to a condenser and thence to the separator.

(8) After steaming, the oxide is removed and replaced by the next batch for extraction, the extractor being again purged.

(9) During the extraction of the next batch, part of the mother liquor and washings may be distilled to recover toluene. The residue from the distillation is a mixture of tar and sulphur, which is discharged through the jacketed cock at the base of the still; this residue may, for example, be 5 lb. of tar and 7 lb.of sulphur per batch.

Toluene is stored in two 120-gal. tanks and moved to and from the process units by two rotary pumps. One tank and the pump above it are reserved for clean toluene, the other tank and pump being used for toluene solutions containing tar and sulphur. Pre-set quantities of toluene may be delivered through the Brodie-Kent meter, and the flow rate is indicated by the rotameter.

An atmosphere of nitrogen at a pressure of 2 in. w.g. is maintained in all the toluene vessels, each of which has an unobstructed connection to a small nitrogen holder outside the plant building.

Radioactive check on coal travel in retorts

If a suitable radioactive substance be introduced into a continuous vertical retort, it is theoretically possible to determine the position of the source of radiation from observations made with suitable radiation measuring equipment external to the retort. The rate and path of descent of the source can be plotted from these observations; discharge of the source from the bottom of the retort is easily detected, and its subsequent location in the discharged coke is extremely simple. In practice, however, there are many factors requiring consideration. A technique developed in the research laboratories of the North Thames Gas Board for investigating the travel of the charge in a continuous vertical retort was described by C. H. Lewis.

The Atomic Energy Research Establishment at Harwell was consulted as to the practicability of the proposed use of a radioactive tally, and as to the most suitable source. The pile-produced radioisotope cobalt 60 was selected for the following reasons: (1) It is readily available in a wide range of activity; (2) the comparatively long half-life of 5.3 years is an advantage, since one source may be used repeatedly over long periods; (3) the principal radiation is in the form of highly penetrating gamma rays; (4) the solid form of the source, coupled with its high melting point (1,480°C.) and low volatility, avoid most of the possibility of contaminating either the coke, the gas or the retort house with radioactive substances.

The sole risk of radioactive contamination arises from the possibility of corrosion or abrasion of the source, which might lead to small fragments of radioactive cobalt or its compounds (such as the sulphide) becoming detached and disseminated throughout a considerable quantity of coke; this can be prevented by enclosing the source in a suitable container. The only risk to people involved in the work is that associated with gamma radiation, which can be minimised by proper precautions.

The source is therefore enclosed in a heat-resisting steel container of cylindrical form, $1\frac{1}{2}$ in. long and $1\frac{3}{8}$ in. diam., with walls $\frac{3}{16}$ in. thick and closed with a screwed plug. This container has proved entirely satisfactory, and has survived over 20 passages through working retorts without sign of deterioration.

In order to secure the maximum range of measurement, the activity of the source must be such that when the radioactive tally is adjacent to the wall of the retort, and as close to the Geiger counter used for measurement as the design of the retort permits, the counter is operating near the upper limit of its working range. An activity of 5 millicuries has been found convenient with the equipment described below, and gives a maximum of about 1,700 counts/sec. when in use.

The essential features of the measuring equipment are (1) a Geiger counter that produces pulses at a rate dependent on the incident radiation and (2) apparatus for recording the pulses from the counter.

The author discussed the experimental procedure adopted, the measurements made and the computation of results of observations. Graphs were plotted of the path of the tally in a lambently-heated rectangular retort. In one series of five experiments the rate of descent of the tally could only be regarded as normal in one case. This was characterised by a fairly smooth descent with a total time of travel of 12.1 hr., and is representative of a number of similar results. In another instance the descent commenced in much the same way but increased at a depth of about 16 ft., so that the total time of travel was reduced to about 9.6 hr. In a third instance the tally proceeded rapidly to a depth of some 18 ft. and then slowed down so that the time of travel was normal at about 12.1 hr. Graphs showing the path of descent were also constructed. Irregular movement was clearly indicated.

During all these experiments, screened coals with a B.S. Swelling Number of 1½ to 6 were being carbonised, so that major irregularities of travel were not to be expected. The retort had been at work for 220 days since reconstruction of the silica belt and top firebrick zone.

It is hoped that further experiments, involving other types of coal and other designs of retort, will be carried out in due course, and that useful information on the travel of strongly swelling coals in continuous vertical retorts will be obtained.

Gasification of carbon

Much work has been published on the reactions between carbon and carbon dioxide or steam. There is now general agreement that the reactions take place in two stages: the formation of a surface oxygen layer, followed by the gasification of the surface carbon atoms by this adsorbed oxygen. The carbon dioxide reaction is retarded by carbon monoxide, and the steam reaction by hydrogen. But there is no agreement on the mechanism of the retardation, nor on the mechanism of closely related reactions such as the water-gas shift. Little is known about the mechanism by which catalysts affect the reactions, or about the nature of the active sites and how their number is related to the surface area of the carbon.

In experimental work described by J. D. F. MARSH, the main objectives were (1) to study the formation of the surface oxygen layer in the carbon dioxide/carbon reaction at temperatures at which the rate of the gasification is small, and (2) to determine whether the reaction of the retardant with the oxygen layer is the cause of the retardation. The author described an apparatus by which the reactions of a carbon sample were studied. A flow system was used, and the reactants passed consecutively over the carbon sample.

The main results obtained were:

When a carbon sample is reduced by hydrogen and then treated with carbon dioxide at a temperature below that necessary for gasification, a reaction takes place producing carbon monoxide and a surface layer of adsorbed oxygen. The volume of carbon dioxide reacting with unit weight of carbon depends on the temperature, the surface area of the carbon and the nature of the surface, which is modified by ash constituents.

(2) This surface oxygen can be removed as water vapour by subsequent treatment with hydrogen. In a series of consecutive runs on high-temperature coke, the average weight of water formed was equivalent to the average volume of carbon monoxide formed during the carbon dioxide treatments.

(3) If a sample of high-temperature coke be covered with a surface oxygen layer and then treated with carbon monoxide, most of the oxygen is removed as carbon dioxide. On the reduced surface, carbon monoxide is then convered to $CO_2 + C$, the rate of this reaction varying greatly with different samples of coke.

(4) The volume of carbon dioxide reacting to give carbon monoxide and a surface oxygen layer on a sample of high-temperature coke does not vary greatly with the partial pressure of carbon dioxide.

(5) The surface areas of the four carbons studied were determined by the B.E.T. method from low-temperature nitrogen adsorption isotherms. For high-temperature coke the area obtained is not a true measure of the surface that can react with carbon dioxide at elevated temperatures to give a layer of adsorbed oxygen.

In the discussion, these results were used to elucidate the mechanism of the water-gas shift reaction, to decide between various mechanisms that have been proposed elsewhere for the reactions between carbon and carbon dioxide or steam, and to explain some published observations on the gasification of coke in oxygen.

Target impact gas burners

In non-primary aerated flames, since the air for combustion must be obtained by a mixing process at the flame surface, the combustion can occur more rapidly the greater the ratio of the surface to the volume of the flame. In other words, for applications where rapid combustion is desired, there is an advantage in arranging the geometrical shape of the gas stream to be such that this ratio is as high as possible. The best form is therefore a thin sheet of gas. This principle is applied in existing types of flat flame burners, in which impinging fluid jets form a thin sheet of fluid which is formed to the normal shape of these flames by the action of the main fluid stream and the shape of the burner.

In many existing types of flat-flame burners, three gas streams are formed, two of which impinge on each other and produce a thin sheet of gas, while the third shapes this sheet and prevents it spreading back into the supply tube. During an investigation of the mechanism of these burners, it was decided that it was possible to omit the third stream and to study the flow system formed by the first two streams. In the course of this investigation the possibility was conceived of using a very simple burner in which a jet of gas was allowed to impinge on a solid obstacle or target, and thus to form a thin sheet of gas similar to that formed by the impingement of the two streams. W. A. SIMMONDS and A. L. WILLETT (Gas Research Board) described this target impact gas burner.

The disc of flame which was obtained with a jet of town gas was shown by preliminary experiments to be stable, and it was consequently decided to investigate the performance of flames of this type over a range of operating conditions.

This burner system can be regarded as producing a lifted non-primary aerated flame from a simple orifice, with the target as a flame-retaining device. It is preferable, however, to consider that the burner produces a thin disc of gas on which the flame is situated, since it is possible to construct a qualitative explanation of the behaviour of these flames on this basis.

The burners consist of two essential parts: (i) a simple orifice by means of which a jet of gas is directed against (ii) a solid obstacle, which thus forms a target.

Although all of the experiments described have been carried out using a burner as described by the authors above, *i.e.* with a solid target, it is not essential that the target should be solid. Burners have been operated successfully in which two similar jets of gas were directed against each other and in which a jet of gas was directed against a jet of air; in all cases discs of flame were obtained similar to those obtained when solid targets were used. There is also the possibility of directing the jet of gas against a liquid target.

These burners have the advantage of great simplicity of design, and consequently may be readily manufactured in any required size. The heat released may be used very efficiently, since the flame can be shaped to the required application. In some circumstances the target may be the surface which it is required to heat.

Target impact burners have the usual advantages associated with non-primary aerated burners and, as with other turbulent flames, the volume of the flame for a given heat release is relatively small.

High-temperature gas furnaces

Industrial processes are so diverse that it is preferable to analyse industrial furnace design by reference to the various features contained in the equipment rather than to the processes carried out in it.

There are three factors to be considered in selecting methods of heating: (1) Temperature. (2) Fuel expenditure. (3) Time.

For instance, almost any enclosure, if properly designed, can be heated to 1,500°C. with low-pressure natural-draught burners, given adequate insulation. At least two of the above factors, however, are almost always operative in any one instance and will exercise a profound influence on the design. Leisurely heating up rates, frequently necessary in ceramic or pottery production, are not often encountered in other industries, and it is becoming increasingly common to demand an appliance that can be operated (*i.e.* heated up, used and cooled down) in one shift or working day. R. F. HAYMAN (North Thames Gas Board) considered each of these factors, any one of which may, upon occasion, be of paramount importance in the design of an industrial furnace.

The term ' industrial gas ' covers a very wide field, and probably one of the most difficult tasks presented is to design equipment that demands an increase of temperature in the minimum time. This brings in its train problems concerning shrinkage and expansion of refractories, including diffi-

culties of resistance to thermal shock. When it is coupled with the additional, always desirable, requirement of using low-pressure natural-draught burners it presents an interesting design problem.

The designing of a furnace that will be economical to run at a temperature of 1,450°C., coupled with the requirements of quick heating and cooling, brings in all the points mentioned above. Such appliances demand hot-face insulation. Fireclay materials are not, in general, suitable in industrial equipment for temperatures above 1,350° to 1,400°C., and the aluminous brick used for 1,500° to 1,600°C. are considerably more expensive than fireclay bricks.

Thermal conductivity is a factor of the highest importance, particularly in conditions involving high temperatures. Until recently there has been an appreciable gap in the literature on the subject of thermal conductivities at high mean temperatures, but sufficient is now known to make it clear that, under the conditions mentioned above, a pore size not greater than 1 mm. is essential in insulating refractory materials for high working temperatures.

When a demand for higher temperatures became apparent the first step in fulfilling it was to design a furnace with improved insulation incorporating superior insulating refractory materials and refractory burners. The basis of the design was the well-known G.L.C. 'B'-type muffle furnace. This new furnace incorporated a recuperator in the form of a simple counterflow heat-resisting cast iron heat exchanger through which air for combustion was drawn in around the flue, subsequently passing around a silicon carbide heat exchanger built into the furnace and separating the air passage from the flue gases. The combustion chamber was lined with high quality aluminous insulating refractory brick backed with fireclay insulating refractory, together with an outer course of diatomaceous brick. A furnace on this basis was developed to operate economically at a temperature of 1,450°C.

Already there is evidence of the need for such furnaces for research in fields ranging from metallurgy to geology. Two furnaces have already been in successful use in research establishments for about 18 months. Interest is, however, now extending to a wider range of temperatures since it has been stated that one new and important development in powder metallurgy will be the sintering of metals and alloys at temperatures up to 1,800°C.

In work of this nature, where so much is untried and where, inevitably, much must depend on the economic production of materials that are now comparatively rare and expensive, it is not easy to predict future programmes of development.

There is the scaling-up of the furnaces to much larger sizes as requirements dictate. Building experimental furnaces of large size is a costly operation and will have to be done in collaboration with industry. Sufficient experience has now been gained, however, to forecast with some confidence that there should be no great difficulty in designing large furnaces to operate at 1,450°C., using insulating refractories and low-pressure natural-draught burners.

There is no doubt that materials of construction will be required to operate under conditions of increasing severity, and long-term work is necessary on the production of very high temperatures where one can utilise to the full the substantial advantage of town gas as a fuel, that of being able to release a large amount of energy quickly, in a small space.

Entrainment of air by flames

The air necessary for the complete combustion of a fuel gas is either premixed with the gas before combustion or is drawn into the flame from the surrounding atmosphere. Except for the case when a fully aerated air/gas mixture is burnt in an enclosed space, as in a tunnel burner, the process of air being drawn into the combustion region always occurs. For a fully aerated mixture, this process becomes one of mixing air with the column of hot gases surrounding the flame and thus diluting the combustion products. For air/gas mixtures containing less air than that required for the complete combustion of the fuel gas, the deficit is made up by air drawn into the combustion region; for non-primary aerated flames all of the air required for combustion is obtained by this method.

Since a flame is a chemical reaction or series of reactions occurring in a stream of gas, the shape and stability of the flame are largely determined by aerodynamic factors. The flow of air into the combustion region is one of these factors and is likely to be of greater importance the less the extent of primary aeration.

The purpose of burning flames is to produce heat to be applied to raising the temperature of a space or of an object. The effect of drawing into the combustion region any air in excess of that required for combustion is to dilute the products of combustion and thus to affect the heat transfer from them.

The flow of air from the atmosphere into a flame thus affects the shape and stability of the flame and the heat transfer from it. To use a fuel gas efficiently, therefore, it is important to have a full knowledge of the amount, speed and direction of the flow of secondary air over the whole surface of flames.

Experimental techniques which have been adapted and tested for following the path of secondary air towards and into flames were described by W. A. SIMMONDS and M. J. G. WILSON (Gas Research Board). These methods have been applied to small, radially symmetrical flames of methane, hydrogen and town gas over a range of rates of flow. In this way the flow patterns have been mapped and measurements of the velocity of the air movement towards the flame have been obtained. The results show that the amount of air entrained into the column of hot gases surrounding the flame at levels below the top of the flame varies only slightly with the rate of flow of gas and with different gases. Apart from the region close to the burner, it has been found that the amount of air entrained increases rather less than in direct proportion to the height above the burner top. In the high-temperature region, measurements of gas composition and temperature have been made, and the flow has been studied. The results have been used for an approximate calculation of the amount of oxygen reaching the flame by diffusion.

The powder method of flow visualisation used in this work is applicable to other fluid-flow problems such as tracing the path of products of combustion through ovens and furnaces and investigating the movement of air in front of fires.

Faults in gas retorts

The development of a leak in a gas retort usually results from a localised attack of the jointing material. A typical leak is probably initiated by a fine crack in a joint of the retort brickwork. Leakage of gases carrying coal ash will then occur and, unless the crack becomes sealed with carbon, a combination of flame erosion and slag attack will then rapidly enlarge the crack until a serious leak results. Though it is possible that holes may be caused by preferential slag attack on the jointing cement, it is highly probable that a broken joint is the commonest predisposing condition. There are several ways in which the bond between brick and jointing cement can be broken. For instance, a jointing material having a high firing shrinkage will almost certainly cause the vertical joints to open, but such shrinkage can readily be controlled by suitable choice of the raw materials from which the cement is manufactured. There is, however, one factor over which little control can be exercised, namely the effects of thermal movement.

A survey of the movement of the exterior faces of a setting of intermittent vertical gas retorts by taking measurements before heating-up, at the beginning of carbonisation, and thereafter at intervals of approximately six months during the working life of the setting, which amounted to $5\frac{3}{4}$ years, was detailed by J. LAMING and W. R. DAVIS (British Ceramic Research Association). Measurements of lateral movement were made by stretching wires parallel to the sides of the setting at certain levels, the distance between the wire and the wall being measured at intervals of from 2 to 4 ft. The relationship between the measurements at different levels was found by plumbing the corner buckstays. Vertical movement was found with the aid of a surveyor's level and staff.

Three main types of movement were observed. Thermal expansion, both laterally and vertically, occurred during heating-up and was followed for several years by a slight growth which was probably caused by the conversion of residual quartz. A second type of movement consisted of a recurrent general tilting of the setting towards the non-producer side wall. Local movements were superimposed on the general tilting.

It was observed that cracks developed within the retorts at a time when the tilting movements were causing distortion of the retorts. The relief of stresses by cracking was accompanied by local changes in the configuration of the side walls and retort tops.

It is suggested that the practice of leaving retorts empty, for the purpose of carrying out hot patching, may have led to the bowing of the retort walls and the consequent hanging of the charge which was observed towards the end of the working life of the setting.

Stress-corrosion cracking in welded gas mains

The failure of welded mild steel work in gas works where it is exposed to incompletely treated gas is familiar to only a minority of gas engineers, as its incidence apparently requires an unfortunate combination of circumstances. Failures are usually first observed when gas liquor starts to seep through cracks running across, or sometimes adjacent to, a weld seam in the gas connections. More rarely, similar cracks appear in shells such as those of the precipitators and condensers. The minimum time for a failure to be noticeable externally is probably about one year. When reports of this type of cracking were first received by gas plant manufacturers, it was thought that they were isolated cases, due to either defective plate or faulty welding technique. However, consultations among the members of the Society of British Gas Industries established that it was unlikely that the failures could be attributed to these causes, owing to the differences in welding technique and sources of steel supply among those members who had reported the appearance of cracking. One or two members of the Society of British Gas Industries initiated investigations into the probable cause of failure, but, when it became apparent that the problem was a general one, the British Welding Research Association was consulted, and a representative Committee was formed to examine the evidence and find an acceptable solution.

The majority of failures reported to the Committee occurred in plant treating gas from continuous vertical retorts, although there were some cases with horizontal retort and intermittent vertical chamber plant; those reported for coke oven gas were few. It seemed that the highest probability of cracking was found in the gas stream between a point at which the gases have been reduced substantially to atmospheric temperature, and the point at which they have been deprived of ammonia.

Among the investigations already in hand when the Committee was considering a programme of work, was that being undertaken at Cambridge University. This had been started with the object of attempting to reproduce in the laboratory an accelerated form of stress-corrosion cracking by the use of corrosive agents such as would be found in a gas stream. Another investigation was being undertaken at King's College, Newcastle, on the effect upon stress-corrosion cracking of various methods of stress relief. In this investigation the corrosive medium used was a hot nitrate solution. An investigation was also being undertaken at the Appleby-Frodingham Steel Works, on the possible protection from stress-corrosion cracking that could be given by spraying other metals on to the surface of the mild steel. In this investigation, the corrosive medium was again hot nitrate solution.

In addition to the investigations already in hand, it was thought desirable that some field tests should be undertaken in which test pieces under stress were required to withstand the actual corrosion conditions present in a gas plant where this form of failure was known to occur. A suitable site was found at Doncaster Gas Works and, with the co-operation of Mr. D. T. Livesey, the chief engineer, arrangements were made for carrying out investigations in this plant. Part of the chosen main could be isolated from the gas stream for several hours at a time and was, therefore, suitable for the insertion and inspection of specimens. This section of the plant was 24 in. in diam. and about 10 ft. in length. The specimens to be inserted comprised different grades of steel subjected to stress applied mechanically or by welding, together with similar samples protected by sprayed metallic coatings. Some samples without surface protection, but which had been given a mild degree of stress relief by heat treatment or by peening, were also included. Field tests were also carried out in the coke oven plant at Margam, in an effort to correlate with practice the laboratory results obtained by Pearson and Parkins at Newcastle.

Conclusions obtained from these investigations were:

(1) The cracks are inter-crystalline and typical of other examples of stress-corrosion cracking.

(2) The cracks are associated with the welds, and cracking invariably starts from the inside of a main.

(3) The cracks are frequently associated with irregularities in the weld bead, *e.g.* where tack welds have been made.

(4) Failures are almost invariably located between the gas cooling plant and the ammonia washers.

(5) It seems possible that external stresses additional to the internal stresses imposed by welding are necessary for failure to occur.

(6) It has not as yet been possible to establish the corrosion mechanism.

(7) The stress relief of weldments by heat treatment at 450 to 500°C. for 1 hr. has been found to give immunity from these failures.

(8) The hot nitrate solution test would seem to be satisfactory for determining relative susceptibility of steels to this form of cracking.

(9) If the nitrate test is considered to be conclusive, shot peening using 3 mm. angular cast-iron shot at 80 lb./sq.in. pressure, and hammer peening using a hardened tool of $\frac{3}{16}$ in. diam. with a $\frac{1}{2}$-in. radiused head would also seem to give immunity.

Low-temperature stress relief down to approximately 300°C. (depending upon the original susceptibility of the steel) would also give an adequate degree of protection.

Plastics Technology

One of the standard works* on the scientific and technological aspects of the ever-growing plastics industry has now been entirely revised for a third edition. A great deal of new matter has been examined in an effort to produce a critical survey and to correlate the scattered data of value to chemists and chemical engineers in the plastics industry. The latest developments in plastics materials are discussed in detail. There are chapters dealing with the history of plastics, raw materials, theoretical principles of polymerisation, the chemistry of plastic materials, the manufacture of plastic materials, the physical properties of thermoplastic and thermosetting materials, synthetic resins, synthetic fibres and textiles, adhesives, plywood and impregnated wood, the manufacture of dies and moulds, the manufacture of plastic articles, the chemical analysis of raw materials and the chemical, physical and electrical testing of plastics.

The information is supplemented by ample diagrams and charts.

In order to keep the book within reasonable limits of size, the section dealing with synthetic elastomers, which was included in the first two editions, has been completely omitted, as it is now considered that elastomeric materials fall outside the scope of normal textbooks on plastics.

The comprehensive nature of the book makes it equally valuable for technicians, chemists, chemical engineers, professional men and students who are seeking more than an elementary knowledge of this subject.

**Plastics, Scientific and Technological*, by H. R. Fleck, M.Sc., F.R.I.C. Third edition. Temple Press, London, pp. 414, including appendices and index, 40s.

Advances in Coal Technology

In the first post-war report of the Fuel Research Board of the Department of Scientific and Industrial Research, London,* details are given of a wide range of research projects connected with the use of coal as a fuel and as an industrial raw material. Below is a summary of those parts of the report dealing with coal carbonisation, including the recovery of sulphur from coke-oven gas, the gasification of coal, the production of oils and chemicals from coal, the catalytic synthesis of methane, and the Fischer-Tropsch synthesis.

FROM April 1, 1946, to March 31, 1949, the period covered by the latest report of the Fuel Research Board, the most important change in the organisation of the board was the transfer of the Coal Survey and the Coal Survey laboratories and their staffs to the National Coal Board in the autumn of 1947. Most of the work on coal preparation has thus now been suspended at the Fuel Research Station, although some of the plant has been retained, as special problems in this field arise from time to time, in the Commonwealth and elsewhere, which can best be investigated at the station.

The special war-time research projects that absorbed the energies of the staff from 1939 to 1946 were wound up quickly at the beginning of the period under review, but the work on the investigation of the German fuel industries was continued into this period, and a detailed study of a great mass of captured German documents enabled subsequent investigations in Germany to be effectively planned and carried out.

There has been a considerable amount of work at the station on repairing war damage and in constructing and installing plant and equipment for the major post-war research programmes. By the end of 1949 the greater part of these necessary preliminary preparations had been completed. Thus, for example, the fabric of the calorimeter building was completed by 1946, but the installation and the testing of the equipment occupied the following three years. Good progress has also been made with the construction of plant for experiments on the burning of pulverised fuel for the gas turbine, and two experimental combustion chambers have been completed.

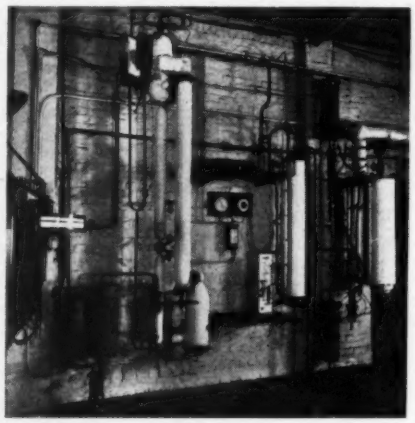
Carbonisation of coal

In addition to the main investigations on the carbonisation of coal, the fuel research organisation has always been concerned with the problems that arise at gasworks and coke-oven installations. Work has been carried out on the dry cooling of coke and enquiries have also been made on the possibilities of recovering sulphur from coke-oven gas either directly as elemental sulphur or by way of spent oxide.

One high-temperature carbonisation plant at the station consists of a setting of two Woodall-Duckham intermittent vertical chambers of nominal capacity of 4½ tons/day of coal for each chamber. The average width of the chambers is 11 in., and each takes a charge of about 2¼ tons of coal. After the plant had been reconditioned, experiments on carbonisation were restarted towards the end of 1947.

Experimental plant for the synthesis of hydrocarbons by the Fischer-Tropsch process, using a fluidised bed of catalyst.

A series of experiments has been carried out at the request of the National Coal Board to determine the suitability of intermittent vertical chambers for the carbonisation of briquettes made from dry steam coal with pitch as a binder. Carbonisation conditions have been found under which the briquettes give a smokeless fuel of the desired properties and, in particular, of the requisite mechanical strength.



Plant for the synthesis of methane using a converter with a moving-bed catalyst.

Recovery of sulphur from coke-oven gas

In 1948 the Imports Substitution Panel of the Lord President's Committee on Industrial Productivity were examining the possibilities of producing more sulphur in Great Britain so as to reduce the amount imported, and they asked the Director of Fuel Research for help in this field. All the processes that are used, or have been proposed, for the removal and recovery of sulphur from coke-oven gas were therefore examined and cost data obtained for them. On this basis a report was submitted by the panel, as a result of which it was decided that two of these processes were sufficiently promising to merit further investigation. The first was the use of tower purifiers to recover sulphur, initially as tar-free spent oxide, from the coke-oven gas that is at present used unpurified. The second was the extraction of sulphur from spent oxide with carbon disulphide, followed, if necessary, by purification by treating the solution in carbon disulphide with oleum. It seemed that, if the German claims for the technical soundness of this second process were correct, it should be successful economically.

At this stage the Fuel Research Station consulted a firm with many years' experience in extracting impure sulphur from spent oxide contaminated by tar. This firm considered that there should be no serious technical difficulty in the production of pure sulphur, either directly from spent oxide containing little tar, or indirectly by extracting contaminated oxide with carbon disulphide and purifying the solution by means of oleum. Experiments were therefore started on the extraction of sulphur from spent oxide obtained from a coke-oven plant which used electrostatic tar precipitators before the oxide boxes. Simple extraction with no purification gave a product containing 99.90% of sulphur, which is pure enough to be used directly for the manufacture of sulphuric acid. By treating the solution in carbon disulphide with a little oleum the quality was improved to 99.98%. Sulphur of 99.90% purity was also obtained by extracting a sample of spent oxide containing 3% of tar and shaking the carbon disulphide extract with 10% of oleum in stages. The same result

**Fuel Research*, 1946-49, H.M. Stationery Office, 1951. Pp. 58. 3s. net.

was achieved by purifying the extract, again in solution in carbon disulphide, with fullers' earth.

Gasification in a fluidised bed

It appears that the only possibility of producing reasonably cheap synthesis gas is to gasify cheap low-grade fuel. A programme of research was therefore started to investigate methods of gasifying such fuels as coke breeze, anthracite duff and washery fines, the particle size in all cases being less than about $\frac{3}{16}$ in. In the present stage of this investigation the possibility is being examined of gasifying these fine low-grade fuels in 'fluidised' beds.

Preliminary experiments in glass tubes of different diameters have been carried out at room temperature and atmospheric pressure with beds of graded coal and coke particles fluidised with a number of different gases and, in this way, empirical relationships have been found between the behaviour of the fluidised bed, the size of the particles, and the velocity, density and viscosity of the gas. The results obtained have enabled the conditions required to fluidise beds of fuel particles in gas generators of any given diameter to be calculated approximately for any given temperature, pressure, gas composition and particle size.

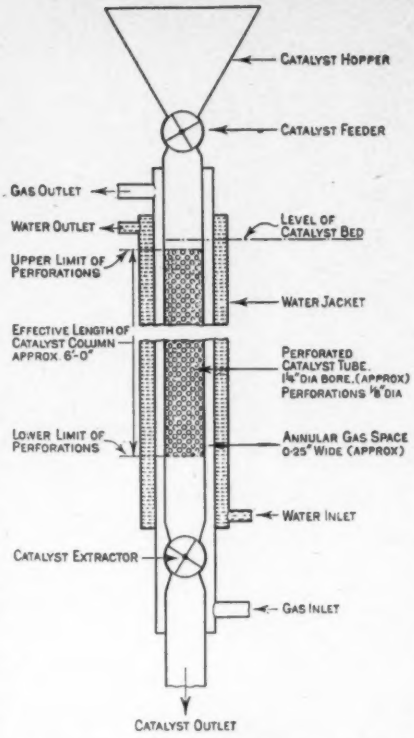
On this basis, experiments in which air was blown through a fluidised bed of incandescent fuel particles have been carried out with the object of studying the factors affecting the design of a full-scale fluidised-bed gas generator. A vertical chamber, 36 in. high and 7 in. in diameter was used for these experiments, in which the temperature of the fuel bed was 800 to 1,200°C. Satisfactory fluidisation was obtained with a Welsh anthracite, a Warwickshire high-volatile weakly-caking coal and a high-temperature coke, in sizes below $\frac{1}{16}$ in. and below $\frac{1}{8}$ in., using a fuel bed up to 27 in. deep. Temperatures measured in the bed were uniform to within 10°C. throughout its depth. The rate of heat exchange between the bed and the walls, and between the bed and solid bodies immersed in it, was measured and was found to be extremely high in comparison with the rates normally found under conditions of forced convection.

The quality of the producer gas obtained in these experiments was poor, the carbon dioxide content being above 10% and the calorific value not higher than about 50 B.Th.U./cu.ft. For the production of satisfactory producer gas in a fluidised bed, it appears that considerably higher temperatures and depths of bed are necessary, and experiments in reactors designed to fulfil these conditions and avoid difficulties due to the formation of clinker are in hand.

Oils and chemicals from coal

Earlier work on sludge formation in the petroleum oils used for scrubbing benzole from coal gas had shown that it was caused mainly by the reaction of unsaturated compounds, indene in particular, with oxygen. This work has been concluded by a study of the chemistry of these reactions, both by measurements of the rate of absorption of oxygen by indene and by an examination of the products; the investigation was ended in 1947. At low temperatures, 25 to 50°C., it was found that oxidation occurred slowly at first, but after some 60 hr. the reaction accelerated autocatalytically. At 25°C. the absorption of oxygen approached completion after about 700 hr., when about 1.7 atoms of oxygen had been absorbed per molecule of indene. The rate of oxidation was increased in certain catalysts, by increasing the temperature or by exposure to ultraviolet light, but the ultimate total amount of oxygen taken up did not increase very much. The most effective positive catalysts were manganese resinate, quinoline, ferrous sulphide, iron acetyl acetonate and pyridine. Aniline and phenol were powerful inhibitors.

Recent work on the oxidation of straight-chain and cyclic olefines has shown that the oxygen first attacks the methylene group adjacent to the double bond, and not the double bond itself. It forms a hydro-peroxide which reacts rapidly to give the oxidation products. It is reasonable to suppose that indene reacts in the same way, and some confirmatory evidence was obtained from the fact that cumarone was resistant to oxidation under conditions which led to the rapid oxidation of indene. Styrene oxidised more slowly and polymerisation of the hydrocarbon occurred to a much greater extent.



Reactor with moving bed of catalyst for the synthesis of methane.

Catalytic synthesis of methane

The enrichment of water-gas by the conversion of part of the carbon monoxide and hydrogen to methane has attracted considerable attention because, if it were economically sound, it would have the advantage of reducing the amount of imported oil that is now used for the production of carburetted water-gas. Work on the synthesis has therefore been continued with a view to collecting information on the technical and economic possibilities of the process.

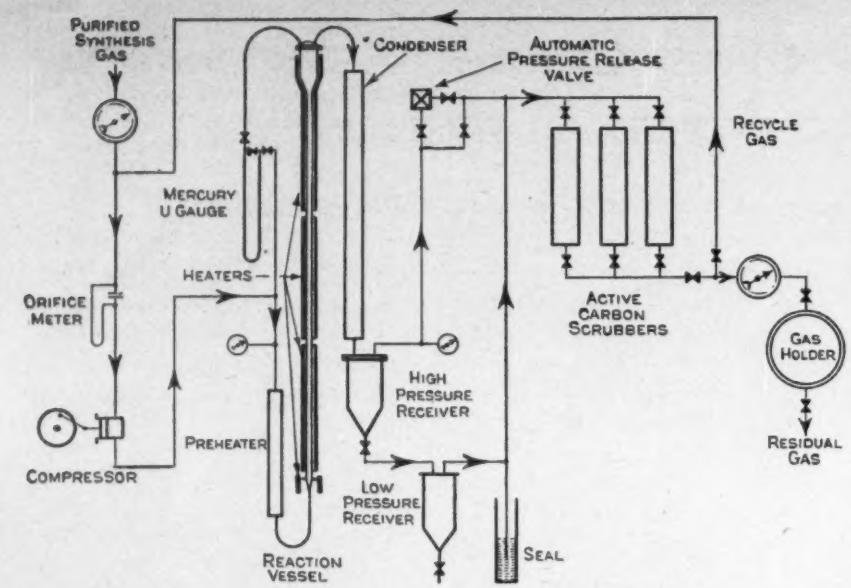
Reactor with a moving bed of catalyst

A reactor to treat 100 to 200 cu.ft./hr. of water-gas was constructed, in which the granular catalyst was placed in a vertical perforated-metal cylinder 6 ft. long and 1.25 in. diam. The cylinder was enclosed in a water-jacketed steel tube of 1.8 in. i.d. The water-gas entered the tube at the bottom, flowed up an annular space and reached the catalyst by free diffusion. The products of the reaction diffused back into the main gas stream in the annular space. This arrangement was found to be superior to reactors of the more conventional design in that a uniform temperature distribution along the length could be obtained and the temperature could be maintained within such limits that the deposition of carbon was negligible. It was also found that the hydrogen in the gas was consumed preferentially so that process gases of low H_2/CO ratio, *e.g.* blue water-gas, could be used without addition of hydrogen. The complete plant consisted essentially of a purification system to remove sulphur compounds from the water-gas, a preheater, the reactor already described with its mechanism for charging and discharging the catalyst, and a thermo-syphon system for circulating water at 200°C. through the jacket of the reactor.

By the beginning of 1948 it was considered that the work described above on the enrichment of water-gas by synthesis of methane had reached a stage at which sufficient technical information had been accumulated to enable a full-scale plant to be designed and operated, if this should ever be required. The investigation was therefore discontinued.

Catalysts for the synthesis of methane

It was found that the presence of promotors other than kieselguhr was not necessary for the production of active catalysts of long life. Kieselguhr itself, however, appeared to be an essential constituent. Reduced nickel carbonate preparations made without the addition of kieselguhr showed no activity for methane synthesis below 300°C., whereas reduced nickel carbonate-kieselguhr catalysts could be prepared which were active at temperatures as low as 150°C. The most active



Experimental plant for the synthesis of hydrocarbons by the Fischer-Tropsch process using a fluidised bed of catalyst.

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catalysts were unduly prone to cause carbon deposition, but catalysts which were relatively free from this tendency could be obtained, with only a slight sacrifice of activity, by the choice of suitable conditions of preparation.

The Fischer-Tropsch synthesis

The study of the Fischer-Tropsch process at the Fuel Research Station has as its object the assessment of the process as a source of liquid fuels, lubricants, waxes, alcohols and other chemical products. In addition to the work on cobalt catalysts used in the conventional way, investigations of iron catalysts and of the techniques of synthesis with powdered catalysts, either fluidised in a gas stream or suspended in oil, have been undertaken.

The fluidised-catalyst technique

Synthesis with a fluidised bed of sintered iron catalyst has been investigated at 300 to 340°C. and 20 atm. pressure, using as reactor a steel tube, 10 ft. long and 1 in. i.d. This contained 1 kg. of catalyst, graded to the range of British Standard Test sieve sizes 72 to 170. The synthesis-gas rate was from 750 to 2,050 volumes per volume of settled catalyst per hr. and part of the residual gas was recirculated in order to suppress the formation of carbon dioxide and to keep the total gas velocity high enough, 0.4 to 0.7 ft./sec., to maintain the catalyst bed in a fluidised state. Under these conditions, yields of hydrocarbons higher than methane have been obtained which, expressed as yield per unit volume of catalyst per hour, were up to 30 times those obtainable by the conventional synthesis with a cobalt catalyst. Considerable operational difficulties were experienced, however, due to deposition of non-volatile products on the catalysts, which in turn caused loss of fluidity and blockages, and also due to the formation of carbon and the resulting disintegration of the catalyst. The carbon appeared to be formed initially inside the pores of the catalyst and to cause the granules to break up. The result of this was that the catalyst bed expanded continuously and losses of catalyst occurred as the finer material was carried over into the condensation system and caused blockages there. In spite of these difficulties, runs lasting from 7 to 15 days have been achieved.

Products of synthesis

The work on the synthesis of lubricating oils from the primary products of the cobalt catalyst process has now been completed and also that on the production of fatty acids by the oxidation of high-boiling fractions of synthesis product. Attempts to purify the soap prepared from synthetic fatty acids, so as to prevent it causing an unpleasant smell to develop on the skin after washing, have been unsuccessful. Experiments with specially synthesised acids of various types have confirmed the statement that soaps made from branched-chain fatty acids possess this property, but it has not been proved that the presence of such acids is the sole cause of the undesirable properties of the soap made from Fischer-Tropsch raw materials.

The March issue

Articles next month will include: Norway's Atomic Pile; Evaporation; Utilisation of Sulphite Waste Liquors.

Titanium Metal Production

STRONGER than aluminium and comparable in strength and corrosion resistance to many steel alloys, titanium metal has come into the limelight in the U.S. where production methods are rapidly developing from the laboratory stage to full-scale operations. As metals go, it is still fairly expensive at $5/lb., but since the U.S. Bureau of Mines research stimulated interest in 1946, much work has been carried out and, although in short supply at present, commercial output is increasing and there are prospects of price reductions.

The Du Pont Co. in America are interested in titanium manufacture and started their first pilot plant in July 1948 at Newport, Delaware. By September of that year, when small quantities of the metal were made available, demand began outrunning supply at a fantastic rate. Output was then only about 100 lb./day. Two larger units were then installed and all three units have been operating ever since. Last April the company's new plant at Newport went into semi-commercial-scale production. It is expected to reach full capacity early next year when its output will be 600 tons p.a. Even then it will continue to be used partly for experimental purposes.

Methods of melting

During these investigations, considerable time has been spent on melting methods. The titanium as marketed by Du Pont is in sponge form and resembles grey coke. Before users in the metals industry can turn it into bars, sheets, etc., it must be consolidated. Two special furnaces have been developed, the design of which has been offered to titanium consumers. Both furnaces are large enough to approach real commercial proportions. In one, more than 15 tons of metal have already been melted, and alloy ingots up to 650 lb. are now being cast. Six such furnaces are now under construction or in operation in the metals industry, and one fabricator reports preparing ingots as large as 1,000 lb. One of the new furnaces, based on arc heating, may form the basis for a unit for the continuous melting and casting of titanium. In it ingots can be formed continuously from molten metal, then cut into suitable lengths.

Once in ingot form, titanium is easier to handle and several U.S. companies have worked it successfully. As sponge metal becomes available in larger quantities they have been turning it into a variety of sizeable semi-fabricated pieces, including sheets, strips, wire, rods, tubing and forgings.

Even as output increases there will remain a shortage, as U.S. defence requirements are taking all available supplies.

Canadian Research on Chemical Engineering and Industrial Chemistry

NATIONAL RESEARCH COUNCIL ISSUES NEW REPORT

The most important scientific research organisation in Canada is the National Research Council which employs more than 3,000 workers, of whom at least one-third are highly trained scientists. The latest account of the Council's work is the 34th annual report for 1950-51. In this, details are given of a wide range of chemical and chemical engineering research. From the report have been taken the following notes on the progress of such projects as industrial fermentations, atomic energy, nuclear engineering, oil-from-tar sands, the standardisation of paint materials and research on pure chemistry.

CLOSE co-operation with the national preparedness programme has brought about notable increases in the activities of the Applied Chemistry Branch.

Oil from tar sands

The chemical engineering section has continued the pilot-plant work on the recovery of oil from Alberta bituminous sands. In the course of the work done during the past year, an investigation has been made into the possibility of using the fluidised bed technique for the conversion of the tar obtained by the water-separation process into a product suitable as feed for refining. The results of this work have indicated that a combination of water-separation with flash distillation in a fluidised bed may provide a satisfactory process for the economic recovery of oil from Alberta tar sands.

Corrosion

Considerable work has been done on corrosion and its prevention. Investigations have been made into the causes of normal corrosion rates in domestic hot-water heaters and internal combustion engine cooling systems. At the request of the Department of Transport, an investigation has also been made of the cause of failure through erosion of locomotive gauge glasses. In addition to the above work, fundamental research is being done on the mechanism of corrosion inhibition and on the oxidation rate of heat resistant alloys at high temperatures.

Paint materials

Work on the standardisation of paint materials has been continued. In this work the protective coatings section has co-operated with the Division of Building Research and with Government departments interested in surface protection. Outdoor and laboratory tests have been carried out on Canadian-produced zinc oxide as a substitute for imported lead oxide as a paint pigment. Identification of the constituents of Canadian marine and vegetable oils is being continued. The object of this work is, in part, to make available alternative sources of drying oils.

Textiles

In the textile field, reports have been published on work done on the evaluation of synthetic detergents in laundering and on the effectiveness of carboxy-methyl cellulose when added to soap solutions. Work on moth-proofing and shrink resistance has been continued. In connection with the latter, it has been shown that improved shrink resistance and wear resulted from the use of wool-nylon mixtures.

Lignin for rubber compounding

Another major project is an investigation which has dealt with the use of lignin as a substitute for carbon black in the compounding of synthetic rubbers of the GR-S type. This work, which is one of the projects sponsored by industry in the Applied Chemistry branch, is being extended to determine the compatibility of lignin with other synthetic rubbers and with natural rubber.

Catalysts

The laboratory work on the use of a new silver catalyst for the protection of ethylene oxide from petroleum gas reactions is nearing completion and it is hoped that the process developed can be tested on a semi-commercial scale in the near future.

Fermentation studies

The research programme originally planned for the Prairie Regional Laboratory is now in full operation, and most of the problems which were proposed for initial work in this laboratory or transferred from the Division of Applied Biology in Ottawa, are under investigation.

Work was continued on the fermentation of sugars by the corn-smut fungus *Ustilago zeae*. Many culture media and cultural conditions were examined to determine the optimum conditions for submerged aerated growth of the fungus for production of the crystalline ustilagic acid, the antibiotics, fats and sterols, and vitamin B_{12}. Effective methods for the isolation of the glucolipid, termed ustilagic acid, were established and the chemical structure of the complex substance was partially determined. One constituent of the ustilagic acid molecule provides a new starting material for the production of valuable musk-like perfume bases (see *Manufacturing Chemist*, 1951, **22** (11), p. 442).

Glucose

The fermentation of glucose by 1,182 bacterial organisms was studied during the past year, and a complete summary of the results prepared. Almost half of the organisms tested gave satisfactory fermentations for the production of glycerol, 2,3-butanediol, ethanol, acetoin, or lactic acid. Several new analytical procedures were developed for determining the products commonly found in carbohydrate solutions fermented anaerobically. Studies on the production of glycerol with *Bacillus subtilis* (the Ford type) were continued. The immediate aim was to establish the conditions that are necessary to give a rapid fermentation with consistently high yields of glycerol from a starch substrate. When a starch substrate is used, some type of saccharification must take place before the *B. subtilis* fermentation will proceed. Certain fungal amylolytic enzymes were found to be effective in this respect, and studies on the production and use of these mould enzyme preparations are in progress. Considerable time was spent in studying the basic mechanisms of the various fermentations concerned. A thorough understanding of the nutrition and metabolism of micro-organisms will not only aid in development and control of industrial processes, but the knowledge obtained from these studies may be applied to higher organisms with consequent benefit to medicine and agriculture. Studies involving labelled compounds and cell-free enzyme systems have been initiated.

Antibiotics

The entire bacterial collection was also tested for antibiotic activity, and 335 organisms were found to be positive against the two test cultures employed. A co-operative programme for the production and testing of antibiotics against several plant pathogens important in Western Canada was begun under a sub-committee of the Associate Committee on Plant

Diseases. The first pathogen selected for detailed study was that causing loose smut of barley and wheat. Active concentrates were prepared from a number of bacterial isolates, and are now being tested against infected barley using a seedling test for the presence of smut infection.

Crop utilisation

The crop utilisation section is primarily concerned with the chemical study of the naturally occurring constituents of crop plants. Work was initiated on analytical methods for determining the degree of polymerization and ramification of starch samples. Some fundamental studies were begun on the interaction of the various functional groups of the commonly occurring sugars in a variety of replacement and isomerisation reactions.

The possibility of using mould enzymes industrially for the solubilisation or modification of protein-containing materials is under study. One immediate application would be in the separation of wheat gluten from starch. A comparative study of several different cultures was carried out to determine relative stabilities, effects of temperature, ability to digest the various protein substrates, and rates of liberation of free amino groups and amino acids. Various methods such as precipitation, dialysis, fractionation and lyophilisation were used in an attempt to concentrate and purify these enzymes.

Work was continued on the spray-drying of wheat gluten. The effect of some of the variables in the drying process upon the nature of the product and its suitability for raising the protein content of low-grade flour is being investigated.

Fundamental studies on the formation of lignin in wheat plants were undertaken during the past year. It was found that young wheat seedlings contained only a fraction of 1% lignin, but that the percentage increased rapidly as the plant headed out. Plants at different stages of growth are being subjected to an atmosphere of carbon-labelled CO_2. Oxidation of the labelled lignin to labelled vanillin (and syringaldehyde) will give an indication of the time of formation of lignin in the plants.

Many theories have been put forward to explain why some straws are weak and others strong, but there is little evidence of a chemical nature to support them. Work undertaken last summer in co-operation with the field Husbandry Department of the University of Saskatchewan has shown that there is a significant difference between the amounts and ratios of vanillin and syringaldehyde obtained by the oxidation of lignin from two varieties of barley, one weak and the other strong. These results are at present being checked and a relationship between this ratio and the strength of straw is being investigated.

Vegetable oils

Results on the composition of rapeseed oil showed a higher value for eicosenoic and linoleic acids and a lower value for erucic acid than reported by other workers. A method of preparing methyl esters in yields of 99.6% with a free fatty acid content of 0.26% by the use of dimethyl sulphate was developed. A dilatometer which employs both gravimetric and volumetric features has been built, and the required apparatus for measurements at temperatures from −15°C to 80°C has been assembled and installed. The melting dilations and coefficients of expansion in the solid and liquid state will be determined for certain free fatty acids and esters. It is hoped to develop a simple analytical method both quantitative and qualitative, for mixtures of the fatty acids and fatty acid esters.

Pilot plants

Work was continued on the development of the pilot-plant areas and on the installation of major items of equipment. A 1,500-gallon fermentor and a suspended centrifuge have been installed. Preliminary tests have been carried out on the evaporator and column, and work is proceeding on the solvent extraction of rapeseed oil. A spray drier was assembled for work on wheat gluten, and a batter tank and screen are being installed for separation of the starch and gluten in flour.

Laboratory facilities have been set up for control of processes and for study of problems encountered in adapting laboratory data to large-scale pilot-plant operation. Attempts are being made to establish suitable criteria for estimating aeration and agitation in submerged-culture fermentations so that the uncertainty in the application of laboratory data to deep-tank fermentations in the pilot plant might be lessened. A solvent-extraction method is being investigated to effect a separation of glycerol from the large amounts of water associated with it in the fermentation process.

Production of experimental strawboard was started early in the year, and some 400 test boards have been made to date. These boards have been subjected to tests of density, tensile strength, flexural strength, and nail-holding capacity, and were found to compare very favourably with standard commercial fibreboards. Attempts are currently being made to evaluate pulps in terms of board properties rather than in terms of cooking and milling treatments. Moisture relations which are encountered in the manufacture and use of these boards are under investigation.

Pure chemistry

By means of a specially designed ultrasonic interferometer, it has been possible to measure the velocity and absorption of sound in the neighbourhood of the liquid-gas critical temperature. A very high absorption of sound was observed near the critical temperature. Further investigations are under way to determine whether this absorption is due to scattering or to some relaxation phenomenon peculiar to the system near the critical temperature. Pressure-volume isotherms have been measured in the critical temperature region for sulphur hexafluoride, the same gas which was used in the ultrasonic measurements. With the aid of the two sets of data an attempt is being made to derive a number of thermodynamic properties near the critical point.

Photoconductivity in anthracene, previously reported by other workers, has been confirmed experimentally. Using the same experiment techniques, no photoconductivity was observed for octadecane. These results are in accord with the theory which ascribes the photoconductivity in anthracene (and in certain dye molecules) to the presence of a conjugated system. Photoconductivity measurements were attempted with β-carotene, a conjugated polyene. These measurements were of interest because of a possible connection between the photoconductivity of carotinoid substances and the process of vision, more particularly cone vision. The retina of the eye is known to contain carotinoid compounds which, if photoconductive, could be associated with the process of light perception. Because of experimental difficulties it has so far not been possible to demonstrate conclusively the presence of photoconductivity in β-carotene, or in vitamin A, which is structurally closely related.

Atomic energy project

The NRX pile at Chalk River has continued to operate throughout the year at a power level somewhat above its designed value, with a maximum flux density of neutrons approximately 6×10^{13}/sq.cm./sec., affording unique facilities to continue investigations of a fundamental nature and providing the means of producing isotopes of higher specific activity than can be obtained elsewhere. The ZEEP reactor has been in operation for investigation in connection with the design of the proposed new pile. The experience and knowledge which the operational and research groups have acquired in the successful operation of these two heavy-water piles has enabled them to design a more powerful reactor, construction of which will be commenced shortly. This new heavy-water pile will be provided with special research devices for continuing and extending fundamental investigations.

The chemical separation plant operated efficiently but, as this is a pilot-plant operation, some modification in the process is desirable. The isotope separation laboratory has been in continuous operation, and the number of shipments as well as the number of different isotopes prepared is double that issued last year. Arrangements have been made whereby the Eldorado Mining & Refining (1944) Ltd. will take over all domestic and foreign distribution of pile-produced isotopes with

the exception of those for clinical use, which will be handled by Charles E. Frosst & Co., Montreal. The plant designed for the separation of the uranium isotope of mass 233 from irradiated thorium was placed in operation during the year and preliminary results are considered satisfactory.

Neutron reactions

Investigations into reactions induced by neutron impact on various nuclei and experiments with accelerated protons, deuterons and tritons have yielded new results of a fundamental nature. Using the electron-pair, neutron and beta-ray spectrometers, the physicists have found new energy levels in the nuclei of a number of different atoms and also have determined the structure of certain compounds, such as deuterised ammonium chloride and carbon tetrachloride. Using new types of scintillation detectors, a high-speed coincidence technique has been developed for work with the beta-ray spectrometer, which has proved very powerful in determining short life-times of the order of a few ten thousand-millionths of a second and in elucidating decay processes. Thus, the disintegration schemes of a number of radioactive isotopes and gamma-ray lifetimes have been determined.

With the high-neutron flux available in the pile, the research chemists have made a number of new isotopes by successive capture of neutrons ; an example is the isotope of phosphorus of mass 33. Several isotopes of the transuranium elements plutonium, americium and curium have been prepared and their properties studied. Work has proceeded on the separation of fission products and methods of separating useful isotopes have been improved. The Biology and Radiation Hazards Subdivision has continued its active work on radiation-induced mutations, tolerance measurements, and has developed the instrumentation and method for making accurate determinations of minute quantities of various radioactive elements in urine. Investigation of biological and biochemical processes with the aid of special pile-produced tracers is being vigorously prosecuted.

Nuclear engineering

Considerable effort has been devoted to testing materials and investigating designs in connection with the new reactor. A special branch of the Research Division, known as nuclear engineering, has been established to deal with the many facets of chemistry, physics and engineering involved in reactor design. The electronics branch has continued its development of various electronic equipment, with special emphasis on millimicrosecond techniques using high-speed oscillographs, and new types of crystal scintillation detectors. Improvement in the design of the quartz microbalance has been made, the development of which is now being carried out by a well-known commercial firm. The special airborne detector designed by the members of the general physics branch for geophysical prospecting for radioactive deposits has been successfully flown during the year in many parts of Canada.

The first section of the chemical engineering research laboratory has been completed, and the engineering design laboratory is now in operation, releasing much-needed space in other laboratories. Additions to the electrical maintenance laboratory, chemical separation plant for the final purification of plutonium, and several other smaller units have been completed. A special shop for making alterations on equipment used in the chemical separation plants has been erected and is in operation. A new laboratory for pilot-plant investigations is nearing completion.

Instrumentation

Among the events of special interest during the year was a joint conference on instrumentation at which representatives from the United States atomic energy plants and from the United Kingdom took part with the local authorities. Special emphasis was placed on the reliability of electronic instruments for radiation detection and measurement. On December 1, 1950, about 30 members of the Parliamentary Press Gallery visited the project and were shown through the pile building and representative laboratories where research and development work was in progress, as well as through the isotope-separation laboratory. This is the first occasion on which an unclassified visit has been made to the project. There have been the usual number of visits from scientists attached to United States and United Kingdom atomic energy projects. During the summer several members of Canadian universities spent some time at the plant working on various experimental and theoretical problems. The programme of lectures by members of the staff continued throughout the year. Many outside addresses to scientific societies and other groups were made by members of the staff. More than 70 papers were presented to meetings of the Royal Society of Canada, Chemical Institute of Canada, Engineering Institute, and Canadian Institute of Mining and Metallurgy, as well as to the American Physical Society, American Chemical Society, American Association for the Advancement of Science, and conferences in the United Kingdom and the United States. There were 56 papers published during the year giving the results of investigations performed at the project.

The number employed at the atomic energy project at the end of the year was 1,208, of whom 411 were scientific and technical personnel.

Mechanical tests for metals

The strength of materials of construction and the probable behaviour of these materials under load has been the concern of designers for very many years. The formulation of suitable tests by which the quality of metal products could be assessed without having recourse to full-scale testing was undertaken by the British Standards Institution as one of its earliest tasks. This resulted in the adoption of a series of standard tensile test pieces. Since that time, a number of British Standards have been issued which deal with different types of mechanical tests and a number of other standards include requirements for specific applications of these tests. The standards that deal solely with mechanical testing, together with extracts from other standards to illustrate particular applications of the tests, have been collected under one cover to form a new handbook, and so provide a reference book useful to industry and to universities and technical colleges where the subject of ' Strength of Materials ' is taught.

The development of standard methods of test and their importance in the field of mechanical testing, are reviewed in an introduction contributed by Dr. H. J. Gough, who is a member of the Mechanical Engineering Industry Standards Committee and was for many years closely connected with the work, being for some time chairman of some of the committees concerned.

The handbook has been arranged in sections which deal with types of tests; seven sections cover tensile tests, hardness tests, impact tests, ductility tests, the transverse tests for cast iron and the verification of tensile and compression testing machines. Each section quotes in full the British Standards for the type of test being dealt with, and continues with suitable extracts from other Standards, where such exist, which illustrate particular applications of the test. The section dealing with tests on thin metal departs from this principle by quoting the whole of a Standard which deals comprehensively with the tensile, bend hardness and ductility tests for thin metal sheet and strip material.

The final section embodies a comprehensive series of conversion factors and conversion tables, which include values of stresses and moments of inertia converted from inch-pound units to metric units and *vice versa*. In addition to a general list of contents and a separate list for each section, an extensive index is included and suitable running headings are given for each page.

Copies of this handbook, No. 13—Mechanical Tests for Metals, may be obtained from the British Standards Institution, 24 Victoria Street, London, S.W.1, price 17s. 6d. post free.

Chemistry in Metal Extraction

THIS was the title of a paper by Dr. F. D. Richardson of the Imperial College, London, presented at a joint session of the chemistry and engineering sections of the British Association for the Advancement of Science at the association's annual meeting. Dr. Richardson pointed out that chemistry enters into the three main steps in the winning of a metal from its ore—concentration, smelting and refining. However, he proposed to restrict himself to the chemistry of metal extraction at high temperatures.

The systems which are most important in this connection are molten metals and molten slags and mattes. Our knowledge is weakest on the last two, so that research is particularly required on the chemistry of molten silicates, oxides and sulphides and their mixtures. Since the nature of liquid metal and slag solutions is only now becoming clear, it is worth reviewing the picture of them which has so far been developed by the application of physical chemistry.

A molten metal consists of closely packed metal atoms, each of which interacts strongly with its eight or so nearest neighbours. The liquid resembles the solid closely, and differs from it mainly in lacking the long-range order peculiar to the crystalline state. Other elements dissolved in metals can be pictured as foreign atoms dispersed among the metal atoms and also interacting strongly with them. They may be distributed uniformly throughout the melt or they may cluster together in some degree. There is evidence, for example, that chromium and oxygen atoms cluster together when dissolved in liquid iron, and so influence each other's behaviour.

Molten silicates consist of disordered three-dimensional networks of tetrahedral silicate groups (SiO_4). These groups share corners with one another *via* Si—O—Si 'bridges.' Every corner is shared in the case of fused silica, which has a high viscosity as a result. These bridges can be broken by the addition of metal oxides. As sodium oxide, for example, is added to fused silica the chains in the network become shorter and shorter, with a corresponding decrease in viscosity, until at the composition 1 SiO_2—2 Na_2O no corners need be shared. Thereafter the addition of more metal oxide gives rise to oxygen and metal ions dispersed between silicate tetrahedra. As much confusion has arisen from theories of the formation of various kinds of molecular compounds in liquid slags, it needs to be stressed that no precise molecules can be identified in such melts. The only entities which can be recognised as having a distinctive existence are the metal ions, the silicate tetrahedra which carry a net negative charge and may be bridged together in varying degrees, and the excess oxygen ions.

The rates of reactions between slags and metals are not controlled by the chemistry of the processes which take place at the interfaces between them. Diffusion of reactants and resultants to and from the interface is rate controlling and diffusion of the slag is usually far slower than in the metal. The rates of refining processes with slags are thus dependent on stirring conditions and the diffusion coefficients of the participating entities in the slag.

The research which is being done today is designed to elucidate the nature of these liquid systems still further. The thermodynamic properties of slag and metal solutions are being measured by gas-slag, gas-metal and slag-metal equilibrium studies. The atomic nature of metals and slags is being solved by measurements of viscosity and diffusion and, in the case of slags, of electrical conductivity and ionic transport as well.

The physical chemistry of metals and slags is a development of the past 25 years. During this time it has mainly been related to iron and steel-making and to such new and costly metals as titanium, zirconium and uranium. The latter are now being produced by methods which spring directly from chemical research. So far as iron and steel and the older metals are concerned, research has been aimed at establishing the physico-chemical background of existing processes. These have been successfully developed by empirical means, so that in a sense the research chemist has here been trying to 'catch up with' the practising metallurgist. The older metal industries do not therefore show any dramatic advances resulting from the application of physical chemistry. They do, however, show many improvements which have followed from a better understanding of what goes on in the furnaces of the smelter and refiner.

Recent work on sulphur in iron-making provides a typical example of the way in which such improvements can come about. Although the scarcity of sulphur may be a headache to the Government and the chemical industry, a surfeit of this element causes a headache to the metallurgist and especially to the makers of iron and steel. The sulphur in iron ore and coke gets into iron when it is made in the blast furnace. Although the majority passes into the slag, which carries around 1 to 2% sulphur, about 0.1% is left in the metal. This causes difficulty in steel-making as it has to be removed as far as practicable by the use of large quantities of a strongly basic slag.

Fundamental thermodynamic studies have lately shown that under normal conditions a sulphur atom can only enter a silicate slag of constant composition by displacing an oxygen atom. The equilibrium between sulphur and oxygen in slag metal and slag gas systems may thus be represented by the equations :

$$(S'') \text{ slag} + [O] \text{ metal} = (O'') \text{ slag} + [S] \text{ metal},$$
$$(S'') \text{ slag} + 1/2O_2 = (O'') \text{ slag} + 1/2S_2.$$

It follows that, in gas-slag systems, a high oxygen pressure tends to push sulphur out of the slag into the gas. It has also been shown that the partition of sulphur between slag and metal, which can be obtained under equilibrium conditions in the laboratory, is much more favourable than that attained in the blast furnace. This is apparently due to inadequate mixing between slag and metal.

A two-fold possibility of practical importance clearly emerges from these fundamental researches. It may become possible to make lower sulphur pig iron by mixing slag and metal in the ladle after tapping—an additional operation, but one which utilises materials already available and at the right temperature. It may also become practicable to recover the sulphur present in the molten slag by blowing air or oxygen through it. Although only 1 to 2% is present, it is readily evolved as sulphur dioxide which could be used for the production of sulphuric acid. The 7,000,000 tons of blast furnace slag made annually in Britain are thus a potential source of 100,000 tons of sulphur.

Inorganic syntheses

The preparation of 53 important compounds, useful in the laboratory but not readily obtainable commercially, is described in this book.* Each of the detailed procedures outlined has been checked in a laboratory other than that from which it was submitted. Syntheses are arranged on the basis of periodic classification, each consisting of an introductory paragraph, a detailed procedure and a discussion of the physical and chemical properties of the compounds in question, together with references.

There are also three survey articles, each of which covers the preparative chemistry of a class of compounds, in an important field of industrial and research activity. Topics covered include : complex beryllium compounds, organosilic compounds and the preparation and properties of the phosphates, polyphosphates and fluophosphates. Many syntheses deal with fluorine compounds of the elements and the use of elemental fluorine and anhydrous hydrogen fluoride.

**Inorganic Syntheses.* L. F. Audrieth, editor. Vol. 3. McGraw-Hill, New York, 1950. Pp. 230 including indexes, $3.75 net.

Design and Performance of Cyclone Separators

By C. J. Stairmand, B.Sc., M.I.Chem.E.

(I.C.I., Billingham Division)

The cyclone has long been regarded as one of the simplest and cheapest types of deduster. It is important largely on account of its comparatively high collection efficiency, its adaptability and its relative economy in power. It is not suitable for dealing with dusts containing a high proportion of particles smaller than 10 microns, for which a more efficient collector such as an electrostatic precipitator, a bag filter or a wet washer must be used. Even in such cases, however, a cyclone can play a useful part in reducing the load on the relatively expensive secondary collector. Here is an abridged version of a paper* in which the author attempts to present a relatively simple picture of the basic principles underlying cyclone design and operation in such a manner that the sphere of usefulness of cyclones can be assessed and plant designed or selected with a reasonable chance of achieving the predicted performance.

IN its simplest form a cyclone (Fig. 1) consists of a cylindrical shell fitted with a tangential inlet through which the dusty gas enters, an axial exit pipe for discharging the cleaned gas, and a conical base with dust discharge. Such a cyclone normally operates with its axis vertical, but as will be seen later it will operate, at least so far as dust separation is concerned, with its axis inclined or horizontal. However, these latter arrangements, which are useful where headroom is restricted, are not normal, and may lead to difficulties in discharging the collected dust.

The main object in a cyclone is to create a vortex which will centrifuge the dust particles to the walls, whence they can be transported into the dust-collecting hopper out of the influence of the spinning gases. The various available designs represent attempts to achieve a high centrifugal force without introducing undesirable secondary effects such as bouncing, eddying, etc., which mitigate against high collection efficiency.

Theory of flow

The simple conception of flow is that the gas spins in the cyclone body in a vortex so that in any horizontal plane the tangential velocities increase as the axis of the cyclone is approached. Experimental measurements have shown that the tangential velocity at any radius is approximately constant at all levels (excluding the extreme top of the cyclone, where the proximity of the cyclone cover slows the spin). Superimposed on the spin there will be a transference of gas from the periphery to the axis of the cyclone, the 'inward drift.' The motion of the gas is thus the result of a combination of spin and inward drift, which, to a first approximation, leads to an inward spiralling of the gas in the manner of a 'Swiss Roll.'

From a knowledge of the throughput and dimensions of the cyclone, and of the friction factor at the walls, it is possible to calculate the actual spinning speed at any radius by equating the energy input to the rate of loss of momentum due to wall friction. The spinning speed at the inlet radius is not necessarily equal to the linear speed in the inlet duct; the ratio of these speeds depends on the balance between the momentum supplied at inlet and the frictional torque imposed by the cyclone walls. From a knowledge of the spinning speeds it is then possible to calculate the forces acting on the dust particles at any radius to determine whether they will drift towards the walls of the cyclone and so be separated, or towards the axis and escape with the cleaned gas.

Further, a knowledge of the spinning speeds enables a prediction to be made of the pressure loss through the cyclone.

These two factors, *viz.*, the pressure loss and the manner in which a particular size of particle behaves, enable the performance of the cyclone to be assessed.

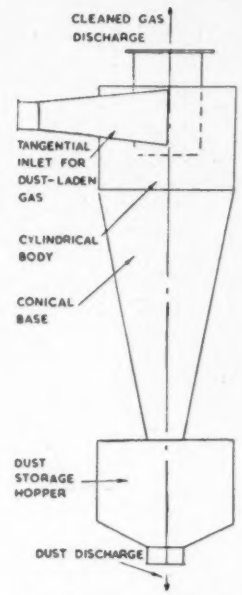


Fig. 1. Simple cyclone dust collector.

Prediction of cut

Since the rate at which the fluid spins in the vortex can be predicted from a study of the flow pattern in the cyclone, it is possible to assess the forces acting on a particle at any point in the cyclone; it will be seen that there is a critical size of particle, of given density, on which the centrifugal and inward viscous forces just balance so that the particle moves neither outwards to the walls nor inwards to the cyclone axis. Thus in a cyclone, all particles larger than this critical size would be collected; and all smaller would escape. The value of the critical particle size is, therefore, referred to as the 'theoretical cut' or, more simply, the 'cut' of the cyclone under the given conditions.

In earlier calculations of cut size, conditions at the wall were considered. Conditions for separation become more favourable as the axis of the cyclone is approached until the edge of the core is reached, because the centrifugal force increases more rapidly than the inward drift up to the core edge. The simple picture is, therefore, of particles rotating in orbits whose radius depends on the balance between the inward drift and outward centrifugal force; particles will transfer to the outer orbits only when they pick up finer particles by collision or are swept there by eddies.

Because of the influence of secondary effects, such as eddying, particle bouncing, etc., a knowledge of the theoretical cut of a cyclone is of limited value in predicting the actual collection efficiency; more accurate prediction is possible by means of a 'grade-efficiency curve' in which the percentage collection is plotted against the size of particle.

Prediction of collection efficiency

If a cyclone worked precisely as a 'Swiss Roll' vortex, a grade-efficiency curve (or fractional-efficiency curve as it is sometimes called) would have the form such

*Presented at a meeting of the Midlands branch of the Institution of Chemical Engineers in Birmingham.

that the cyclone has zero efficiency for all particles smaller than the 'cut' size and 100% efficiency for all particles larger. Thus, in this case the overall collection efficiency for a particular dust would be given simply by the percentage by weight of particles in the dust sized coarser than the 'cut' of the cyclone.

In practice a considerable number of particles smaller than the 'cut' are separated with the coarser particles, possibly by collision with them or on account of particle aggregation; also a number of particles coarser than the cut escape with the 'clean' gas, being carried into the inner vortex by eddies or by bouncing. So far it has not proved possible to predict from theoretical considerations the whole of the grade efficiency curve, particularly since the degree of enhancement in efficiency for sizes below the cut depends largely on the properties of the dust. The most general method of preparing a grade efficiency curve is, therefore, by means of a series of practical tests. This presents considerable experimental difficulty, particularly with modern high efficiency cyclones, since only small samples of the dust escaping collection are normally available. Great accuracy in sampling and size analysis is necessary if the resulting grade efficiency curves are to be of value for predictions of cyclone performance.

Further, it will be appreciated that the grade efficiency curve, when prepared from a particular test on a given cyclone and powder, strictly refers to that experiment only. However, by applying the basic laws of flow in cyclones outlined above, it is possible to transpose the grade efficiency curves *over limited ranges* to cover changes in powder grading and density, and cyclone scale, and to an even more limited extent to cover changes in cyclone throughput.

Secondary effects affecting efficiency

It is convenient at this point to consider the reasons for the failure of a cyclone to collect all particles coarser than its theoretical 'cut,' and to see how far these effects can be reduced or eliminated in a practical design.

The cut of a cyclone has been considered in terms of a uniform inward drift, opposed by centrifugal forces. In practice this drift is not necessarily uniform, but may at certain points exceed the mean by a factor of 2 or 3, particularly at the ends of the cyclone where the additional frictional surfaces induce precession currents. A little consideration will show that doubling the inward drift velocity at any point would result in some particles 40% larger than the cut size reaching the exit.

A further secondary effect is caused by eddies in the vortex. The eddies are of course random, and will also carry smaller particles to the walls and thus aid separation. In practice, therefore, this particular effect may not affect the overall percentage collection to any great extent.

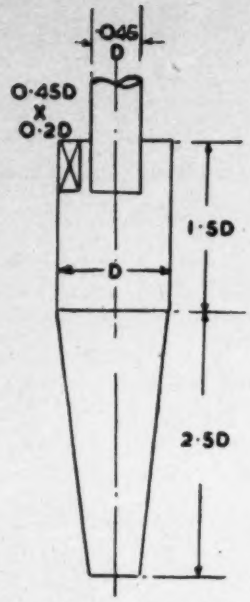


Fig. 2. Long cone cyclone —typical proportions.

A third, and more serious, cause of cyclone inefficiency arises from 'base pick-up.' The description of the flow in a cyclone outlined earlier in which the gases were visualised as flowing in a simple 'Swiss Roll' is an oversimplification, and a double eddy in the vertical plane is superimposed on the main flow. This assists the collected dust in its descent into the dust hopper, but also carried collected dust back into the inner ascending vortex. This effect of base pick-up has been shown to be the major feature contributing to excessive emission in a poorly designed cyclone and is much worsened by any additional vertical flow induced, for example, by a poorly sealed dust discharge.

It seems that a cyclone should be designed so that the vortex is as uniform as possible, and generally so that the highest spinning speeds are achieved with the least expenditure of energy. This calls for accurate construction and smooth interior finish with no protuberances. As far as possible, stray eddies should be avoided, and the distance between the dust discharge and the lower end of the clean gas discharge should be as great as possible consistent with meeting space limitations.

Many manufacturers use a special scroll-type inlet, with the intention of reducing disturbance of the vortex when the inlet gases join the main flow. It has been the author's experience, supported by an extensive study in transparent models, that such special arrangements have little advantage in an otherwise well-designed cyclone, since disturbance at the inlet can be reduced to negligible proportions by arranging that the spinning speed at inlet radius is about 5 to 10% higher than the mean inlet velocity.

These considerations lead naturally to the 'long-cone' design (Fig. 2), which, when fitted with a dust hopper, probably represents the best available practice. The claims of other designs such as nested vane-ring units or common inlet groups rest mainly on lower resistance or smaller space requirements.

Cyclones for special duties

(a) *For particularly fine dusts.* Where particularly fine dusts must be collected cyclones more than 4 to 5 ft. in diameter do not generally give a good performance. The use of small diameter nested cyclones is of some assistance, but the danger of chokage cannot be overlooked; in general, a better plan is probably to employ two sets of larger cyclones in series or follow a normal cyclone by a secondary collector.

(b) *Coarse dusts.* While the separation of coarse dusts appears at first sight to be relatively easy, in fact, some special problems may be encountered, *e.g.*, bouncing, and breakdown of coarser aggregates that would otherwise be separated, into particles too fine for collection by the cyclone. The solution in this case is to separate the coarse material in a precollector, which may be a cyclone of fairly normal construction working at very low spinning speeds, *e.g.*, 5 to 10 ft./sec., or even a simple settling chamber. In general, however, some simple shutter-type collector in which the gases are subjected to a sharp change of direction, is to be preferred because of the saving in space it may permit.

(c) *Sticky dusts.* Where a dust is sticky its collection usually presents few difficulties since it often agglomerates easily, but trouble may arise through chokage of the cyclone ducts and discharge orifice. These difficulties can be minimised by keeping the velocities above about 50 ft./sec. or by heating the cyclone walls and ducting. Chains hanging from the lower edge of the clean-gas exit pipe have been claimed to avoid chokage by dislodging the deposits, and blockage of the clean-gas exit pipe has been avoided by similar means.

Irrigated-wall cyclones might also provide a solution but a satisfactory spray eliminator is necessary to avoid serious trouble in the exit ducting. The efficiency of an irrigated cyclone will probably be very high for any dust, since not only does the wetted wall avoid chokage, but it also greatly reduces secondary effects such as bouncing and base pick-up. The added complication introduced by the use of a wet system must, however, be offset against the advantages gained.

(d) *Cyclones for restricted space.* Where cyclones have to be erected in limited space, small diameter nested cyclones have obvious advantages.

Further, small cyclones are claimed to be more efficient than similar cyclones of larger diameter. In the author's view this is only partly true, because the full theoretical advantage of small cyclone diameter is not obtained for a variety of causes,

among which can be numbered the following:

(i) The effects of bouncing, eddying and re-entrainment are enhanced.

(ii) There is usually a loss in efficiency in compounding together a number of small unit cells.

(iii) Very small diameter cells (of the order of 3 to 6 in. body diameter), are not completely free from risk of chokage when dealing with the finer stickier dusts.

It should be noted, however, that not all manufacturers of small-cell units aim at higher efficiency when proposing the use of nested multi-cells, but rather at lower pressure drop and more compact installations.

(e) *Cyclones for limited headroom.* A cyclone running horizontally requires considerably less headroom than one placed vertically and offers certain advantages in restricted spaces. Care should be taken before such a plan is adopted, however, as model tests have indicated that a quantity of powder may become trapped at the gas exit end of the cyclone and, building up in concentration, may slow the spin and eventually leave the cyclone *via* the clean gas exit.

Also, while relatively fine particles are satisfactorily carried into the dust hopper by the precession currents in the cone, coarser particles may fail to ascend the lower edge of the cone and may accumulate and eventually choke the discharge. In general, therefore, horizontal cyclones are not favoured, though inclined cyclones appear to obviate these two major disadvantages and their use may save considerable headroom, especially in the larger sizes.

Conclusion

The main features of a well-designed cyclone are a smooth, truly circular body, with an inlet which will introduce the gas with a minimum of disturbance to the spinning vortex in the body of the cyclone; an exit pipe located axially, preferably of small diameter compared with the body, so as to obtain the maximum separating effect consistent with reasonable pressure drop; and a dust discharge designed to prevent re-entrainment of collected dust.

When considering proprietary designs they should be studied to see how far the preferred features have been incorporated, bearing in mind the duty envisaged. Often special features are claimed; they can generally be assessed in terms of the above remarks.

The Fat-Hardening Industry

THIS book* has been written 'to present a review of the development of the fat-hardening industry in the light of the most important researches.' The author has concentrated mostly on the work of his own Dutch school and, while this is justified by the declared purpose of his book, it has not resulted in a properly balanced account of the subject. Nevertheless, it is an addition to the literature that will be valuable and instructive to scientists in the oils and fats industry.

The first half of the book describes in theory and practice the operations that are preliminary or ancillary to the process of hydrogenation. In this section the account of the pressing and extraction of the raw materials is particularly good, especially the latter about which comparatively little has been published, though the process is becoming more common in the industry. Another very informative account is that dealing with the preparation of nickel catalysts. It would be a service to the industry if the author extended his description of the technical preparation of hydrogen to bring it up to the same high standard, though it is realised that this subject is probably not so directly allied to his own researches as is the preparation of catalysts.

Technically, deodorisation is a very interesting part of the treatment of hydrogenated oils and, though Prof. Waterman's description of it is adequate, again we think that those who will read his book would be grateful to him if he extended this part.

It is right that in this book the operations leading up to hydrogenation should be dealt with in some detail. The author is to be congratulated on his handling of these subjects. It must be difficult to adjust the lengths of these chapters so as to give all the information that is necessary without being led too far away from the main theme of hydrogenation.

The second part of the book deals with various aspects of the theory of hydrogenation—the thermodynamics of the process, the effect of catalysts, the temperature distribution throughout the reaction mass and selective hydrogenation. Also there is a brief consideration of such side reactions as isomerisation, polymerisation, interesterification and migration of the double bond. There are also sections on plant and equipment, economic aspects, high-pressure hydrogenation of alcohols, and possible future developments such as conjugated hydrogenation and reactions with atomic hydrogen.

The book has been translated from the Dutch, but there are few passages where the style betrays this fact. The use of 'intensivation' instead of 'intensification' on page 236 is the only fault of this kind I detected. There are minor misprints on pages 10, 44, 111 and 189.

In the paragraphs dealing with the disposal of soap stock from the refining of edible oils, no mention is made of 'degrading' it to a charge of oil for soap-making. Where, as is common, soap oils and edible oils are refined in adjacent plants, this is the usual method of disposal.

J. L. BOYLE, PH.D.

**Hydrogenation of Fatty Oils*, by H. I. Waterman. Elsevier, London, 1951. Pp. 254, including index, illustrated, 42s. net.

Oils and fats

The production, refining and uses of oils, fats and waxes is dealt with in a new book* which is designed to interest all who are in any way connected with oils and fats from the grower to, for instance, the manufacturer of soap or paint. It is a book of general information rather than an authoritative discussion of a particular field.

In the first section the author deals with vegetable oils and fats, including oil-bearing plants, the processing of oil seeds and the refining of oils and fats. In his next section he deals with milk and milk products, next with animal oils and fats, and then with waxes. Next comes a series of short chapters on petroleum- and coal-derived oils, essential oils, edible oils and fats, margarine, soap, glycerin, sulphonated oils, paints, stearines, oils and fats in textiles and in the leather industry, lubrication, protective oils and, finally, a section on international trade in oil seeds and oils.

This very brief summary of the contents shows that the book is emphatically not one for the specialists but rather one for those desiring general information on oils and fats.

**Die Ole und Fette in Wirtschaft und Technik*, by P. F. Rickmers. Ziolkowsky, Augsburg, Germany, 1951. Pp. 272, D.M. 16.50 net.

Radioactive isotopes

Readers interested in the research and industrial possibilities of radioactive tracers will welcome this small book* which gives information on the subject. It opens with short chapters on nuclear physics, nuclear reactions, the production and distribution of radioactive isotopes, stable isotopes and legal aspects of atomic energy. Then comes a most interesting chapter on isotope techniques, which is followed by five chapters describing respectively the uses of isotopes in pure research, biology, medicine, agriculture and industry. An appendix lists isotopes normally available from the A.E.R.E. at Harwell. If this unpretentious little book helps to spread more widely the knowledge of the peaceful applications of atomic energy it will have fully justified its publication.

**Applied Atomic Energy*, by K. Fearnside, E. W. Jones and E. N. Shaw. Temple Press, London, 1951. Pp. 156, including index, 8s. 6d. net.

Plant and Equipment

Base-exchange water softener

Simple manual controls and a convenient salt-handling system are features of a new base-exchange water softener introduced by the Permutit Co. Ltd. This D.L. type softener consists of a closed steel shell, containing a bed of base-exchange material supported on a layer of crushed flint, termed Silex. A collecting system for the withdrawal of softened water is embedded in the Silex.

The water to be softened enters at the top of the shell and is uniformly distributed over the base-exchange bed. It then passes evenly downward through the material, and the hardness is removed by base-exchange action. The softened water flows through the supporting Silex layer and into the collecting system, whence it leaves the softener and flows away to service.

Externally, the plant has an assembly of stop-valves for controlling the regenerating sequence, and a meter is fitted to show the amount of water softened. A storage arrangement for salt is also provided.

With the smaller sizes of plant this storage takes the form of a cylindrical tank placed alongside the main softener shell. This tank is filled with dry salt, and water is added to form salt slurry and saturated brine. The latter is introduced into the softener by a hydraulic injector operated with pressure water taken from the inlet main: no auxiliary power is needed, and the brine becomes diluted during passage through the injector, and reaches the base-exchange material at the correct strength for efficient regenerating.

The suction pipe in the storage tank is provided with an adjustable disc which indicates the amount of brine to be used, and when this volume has been injected more water is admitted to the tank to form fresh brine from the slurry remaining. The procedure is repeated for a predetermined number of regenerations until the salt has been used, and the tank is then refilled. There is no double handling of salt and measurement of the amount required for each regeneration is done volumetrically in the form of saturated brine of constant strength: no weighing is needed. The storage tank can be large enough to hold sufficient salt for any reasonable number of regenerations, weekly filling being the usual basis.

With the larger D.L. type Permutit plants salt is stored in a concrete, masonry, steel or timber tank, and the amount of brine needed is measured in an auxiliary tank placed alongside the softener. As with the smaller units, brine delivery is by hydraulic injector, and inflow of make-up water to the storage tank is controlled automatically by a ball valve. This salt storage system permits the purchase of loose salt in bulk, thereby enabling it to be obtained more cheaply than is the case when supplied in bags.

A further saving results on the cost of replacing damaged bags. In this respect it is well known that salt in bags will harden after only a few weeks in storage, and it frequently happens that many bags are split by the plant operator in his efforts to loosen the salt before the bags can be emptied. The cost of these may well increase the cost of salt by as much as 50%.

Shield for electric welding

A water-cooled shield for use on a high-current Argonarc torch is stated to permit constant use of current up to 350 A. in welding thicknesses of up to ¼-in. copper and ½-in. aluminium plate without any danger of overheating or shield failure.

Water-cooled shield which allows high welding currents to be used safely.

The components of the accessory consist of a chromium-plated copper water-cooled shield, an insulated shield adapter, interchangeable nozzles in three sizes, a T-junction for hose connections, 15 ft. of P.V.C. tubing for the water drain, 9 ft. of P.V.C. tubing for connection to the master valve, a steel hose clip and a lengthened collet key for electrode removal. The shield is supplied by the British Oxygen Co. Ltd.

Calculator for belt drives

To work out the most efficient and economical width of belt for any particular drive involves a good deal of calculation and usually requires the use of a slide rule and belting tables. A new device solves this problem in the simplest possible fashion. It is a calculating rule so designed that it can be used even by those who may be unfamiliar with the ordinary slide rule. To find the belt required for any particular drive it is only necessary to set the slide so that the pulley diameter coincides with the pulley revolutions per minute. It is then possible to read off at a glance belt speed in feet per minute and the width of the belt required to transmit any given horse-power.

The calculator may also be used in a variety of ways when designing belt drives. For example, when given size and speed of motor pulley the speed or diameter of the driven pulley can be determined without further setting. Also, the corresponding belt speed can be read through a window in the slide for all settings of the slide. A table also provides the minimum recommended pulley diameters for all thicknesses and types of belting.

This simple procedure is achieved by the use of a reversed logarithmic scale which enables all the required answers to be given with one setting of the slide. Width and thickness are given alternatively in solid woven hair belting, rubber and canvas ply belting and belting woven from *Filastic* yarn. These three types of belting are made by Lewis and Tylor Ltd., who have produced the new calculator. They offer it free to engineers and executives.

Catalyst sampling device

A hopper device that permits workmen to take catalyst samples without interfering with the operation of a cracking unit has been developed in America. With the new device it is claimed that it is no longer necessary to stop operation of the bucket elevator conveyor that carries the catalyst from a regenerator to the cracking unit.

The device is lowered through an access door into the elevator hopper. The catalyst falling from the regenerator into the hopper fills the device, which is then withdrawn so that the condition of the catalyst can be checked. Previously workers had to stop the elevator and take the sample with a scoop from the hopper, temperatures of 900°F. and the danger of spilling catalyst in the unit and causing expensive shut-down time making the operation difficult.

Nylon-strengthened diaphragms

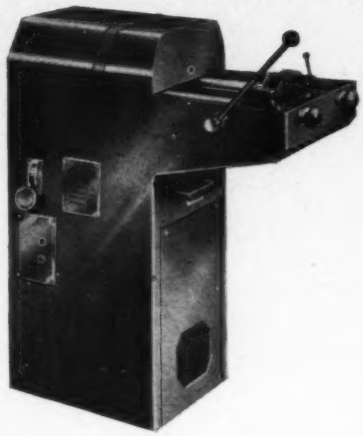
A diaphragm of moulded synthetic rubber strengthened with nylon fabric has been produced by the Rockwell Mfg. Co. in the U.S.A. to improve the precision of gas-pressure control with high-pressure balanced-valve pilot-loaded regulators, to aid in the assembly of diaphragms for such equipment and to increase service life in regard to diaphragm maintenance. The diaphragm should replace flat leather or synthetic types.

Because of its moulded shape, the free area is claimed to roll easily and smoothly. Pressure variations are minimised and easier assembly assisted by an extra thickness of rubber at clamping areas, which also ensures sealing and reduces the possibility of cutting the diaphragm. Gas seepage is stated to be prevented by the weave employed and by sealing off the nylon insert well back from the outer edges. The synthetic rubber resists hydrocarbons.

World News

High-speed screwing machine

A ⅜-in. single-spindle screwing machine, for the high-speed threading of bolts, pipes and small components, has recently been introduced by Chamberlain Industries Ltd.



Single-spindle high-speed screwing machine.

The pedestal of the machine comprises two side panels pressed out from mild-steel sheets which form an integral part of the cutting lubricant and swarf cradle, obviating joins in the pedestal construction which would allow cuttings to escape. Small angle sections within the pedestal provide the securing of the side panels and, together with the motor, cutting lubricant reservoir and bearing housing platforms, assure the complete rigidity of pedestal construction necessary for precision thread cutting. At the front and rear removable panels allow complete access to the interior.

The elimination of any outside foundation bolts or pipe fittings, which are all totally enclosed inside the pedestal, enables the operator to walk around the machine without the interruption of extraneous fittings.

Radioactivity detector

Development of a new radioactivity detector, said to be safer and nearly 20 times more sensitive than the present Geiger counter, has been announced by the Pennsylvania University, U.S.A. The new instrument, called the scintillation counter, would permit doctors to use smaller amounts of dangerous radioactive material in diagnostic tests and increase greatly the use of these substances in the diagnosis of disease.

The instrument utilises a property of certain common crystals which emit visible light when exposed to the radiations of radioactive substances.

For further information on new plant and equipment, please complete the coupon on page 98.

GREAT BRITAIN

Glassware needs of Low Countries

Mr. Brian H. Turpin, technical and sales director of Quickfit & Quartz, Ltd., a member of the Triplex group of companies, who recently returned from a business tour of Holland, Belgium and France, said that technical development in the Low Countries had progressed rapidly and was beginning to compensate for the lost war years.

'These countries offer an excellent market for British industrial and laboratory glassware,' said Mr. Turpin. 'They are eager to bring their scientific and industrial equipment up to date and they want British chemical glassware to help them in this respect.'

I.C.I. dyestuffs expansion

Imperial Chemical Industries' dyestuffs division has undertaken a big expansion of its plant at Huddersfield. The amount involved for the erection and installation of new equipment for the manufacture of dyestuffs and the intermediate products required for dyestuffs is over £4,000,000. When the work is completed it is expected that a further 500 men will be required at the Huddersfield plant.

Gas Council's new chairman

Col. H. C. Smith, M.Inst.C.E., M.Inst. Gas E., succeeded Sir Edgar Sylvester as chairman of the Gas Council at the beginning of the year. He had been deputy chairman since 1948. He is chairman of the Gas Research Board and a member of the Scientific Advisory Council appointed by the Ministry of Fuel and Power. Col. Smith was born in 1890 and entered the Birmingham Gas Department in 1906. He joined the Tottenham & District Gas Co. as works superintendent in 1920, and was appointed chief engineer in 1922, general manager in 1943, managing director in January, 1946, and deputy chairman in November, 1946. From 1947 to 1949 he was chairman of the British Gas Council and for many years he was also chairman of the London & Counties Coke Association and other bodies concerned with solid smokeless fuels. He succeeded the late Sir David Milne-Watson in 1943 as chairman of the Federation of Gas Employers. He was president of the Institution of Gas Engineers in 1937/38.

Nitrogen Directorate wound up

The Directorate of Nitrogen Supplies came to an end on December 31, 1951. On January 1, 1952, matters concerning the production of ammonia and the provision of ammonia to industry, including the fertiliser industry, became the responsibility of the Ministry of Materials, Division 2, Branch 2A, at Horse Guards Avenue, S.W.1. Matters relating to the production and distribution of fertilisers within the U.K. are being dealt with by the Directorate of Fertiliser Supplies, 56 Mount Ephraim, Tunbridge Wells, Kent.

Study of U.S. plant maintenance

Maintenance of plant has assumed added importance in the present drive for higher productivity. The Anglo-American Council on Productivity has accordingly arranged for a team of British specialists to study current practice in the U.S.A. The members of the team come from all branches and levels of the engineering industries and included G.E. Halter, plant engineer in charge of refineries, National Oil Refineries, Ltd; T. C. Robinsons works engineer, Billingham Division, I.C.I. Ltd.; E. Stanley, foreman, Reckitt & Colman Ltd.; and D. G. Hitt, chief engineer, Anglo-Iranian Oil Co. (New York office).

The team arrived in U.S.A. at the beginning of last month and is expected back towards the end of this month. Visits to undertakings, mainly in the Eastern States, occupied in engineering and in the manufacture of food, textiles, steel, paper, and wood and oil products, were planned. The team was charged to devote particular attention to what is known as 'planned preventative maintenance' and to investigate American wage structures and safety precautions.

Nitrogen consumption increases

Global estimates for the year 1950/51 show a continuance of the upward trend in both production and consumption of nitrogen, according to the annual report of the British Sulphate of Ammonia Federation, Ltd. Total production rose by about 5% and amounted to 4,972,700 metric tons. Consumption of nitrogen increased by 17% to 5,022,700 metric tons. Agricultural consumption, estimated at 4,290,000 metric tons, exceeded last year's figure by 12% and was slightly above the output for the year. Several plants in various countries which were due to start in 1950/51 will not commence production until 1951/52.

The total U.K. production of nitrogen products in the calendar year 1950 was 6.2% higher than in 1949 and amounted to 1,803,400 long tons. Output of fertiliser products fell by 2.6% but there was an increase of 40% in industrial forms. The decline in fertiliser consumption was partly due to bad weather and to the removal of part of the subsidy.

Exports from the U.K. were 14% less during 1950/51 than in the preceding year but totalled 240,718 long tons. The three

chief consumers were Ceylon, who took 36,000 tons, British West Indies 31,467 tons, and Eire 30,135 tons.

The Federation's research department has paid special attention to the question of materials of construction. Experiments on the use of resin cements and lacquers for protective coatings have been intensified and a fair measure of success achieved.

Tungsten and molybdenum allocations

The U.K. allocation of tungsten ores and concentrates for the first quarter of 1952 amounts to 774 metric tons (metal content) and that of molybdenum to 545 tons, according to the Tungsten-Molybdenum Committee, of the International Materials Conference. For this quarter the Committee estimates the total production in the free world at 3,700 metric tons of tungsten and 4,800 tons of molybdenum. Allocations for the U.S. in the same period are 1,748 tons of tungsten and 3,644 tons of molybdenum.

In making this allocation, the Committee distributed tungsten ores and concentrates on the same basis as for the fourth quarter of 1951, with an increase of 12½% in the quota for each country.

Copper and zinc allocations

A total of 100,000 metric tons of copper and 64,000 metric tons of zinc have been allocated to the United Kingdom for the first quarter of 1952 by the Copper-Zinc-Lead Committee of the International Materials Conference. Only primary copper and zinc have been allocated. Semi-fabricated products have not been allocated. Exports of the latter are to be maintained, however, at levels commensurate with the exporting country's metal allocations. The demands for defence and essential civilian needs have increased over the fourth quarter of 1951. In view of this, it has been decided, temporarily, to make no provision for strategic stockpiling.

Potable spirits output

The total production in the U.K. of spirits (ethyl alcohol only) by the fermentation-distillation process during the year ended September 30, 1951, was 89,974,450 proof gal. This figure includes 12,226,252 proof gal. of spirits distilled in Scotland at distilleries using malt only and 14,836,548 proof gal. distilled in Scotland at distilleries using malt and other materials.

Chemical glassware plant extensions

Last month the foundation stone of an extension to the Quickfit & Quartz, Ltd., premises at Stone, Staffordshire, was laid. This extension, working in conjunction with existing premises at Stone, will substantially increase the output of the factory, already the largest in the British Commonwealth producing specialised types of industrial glassware. The new factory will produce chemical plant, including the world's largest glass pipeline with a diameter of 18 in. New annealing furnaces, and other special equipment will be features of the extension.

Powder processing machinery redesigned

With the recent change in the board and management of Wm. Gardner & Sons (Glos.) Ltd. the reorganisation of their factory is being completed for the production of a redesigned range of machinery.

This company, which was founded in 1860 for the repair and maintenance of the grinding machinery of the early watermills and windmills, was one of the first manufacturers of sifting, mixing and grinding machinery for a number of industries. The self-raising flour industry was based on these machines. Since then they have been used in every industry where powder processing is required.

Based on this experience, the redesign of their complete range was commenced over a year ago to make each machine a self-contained unit incorporating the latest improvements for easier cleaning out, greater accessibility and a further reduction in the time required for maintenance and attention. These machines are now constructed of prefabricated steel, are totally enclosed for dust-free operation and have self-contained power units.

Having been fully tested in practical operation for some time, the machines are now going into full-scale production as standard units. The company, however, still maintain their policy of experimenting and testing customers' particular products for the manufacture of special machines where necessary.

Organic chemicals dearer

Owing to raw material difficulties, with consequent increases in costs of production, the selling prices of certain organic chemicals marketed by British Industrial Solvents, Ltd., were recently increased. The new prices per ton, carriage paid, in packages returnable at seller's expense, are as follows:

Acetone. Increased by £30 for delivery in bulk and in 45-gal. drums, by £35 in 10-gal. cans, and by £40 in 5-gal cans, to prices varying between £112/ton for 50-ton lots to £145/ton for 5-gal. can lots.

Isopropyl acetate. Increased by £10 in all categories, to prices between £158/ton for 10-ton lots to £190/ton for 5-gal. can lots.

Lobosols. Increased by £3 to £19 according to type, to prices ranging between £105/ton and £174/ton, depending upon type and quantity.

Tar Confederation officers

The following have been elected officers of the British Tar Confederation for 1951/52: Sir Walter Benton Jones, *president*; Mr. C. E. Carey, *hon. treasurer*; Major A. G. Saunders, *chairman of the executive board.*

AUSTRALIA

Chemical interests merger

The Distillers Co., Ltd., of Britain and the Colonial Sugar Refining Co., Ltd., of Australia have decided to amalgamate chemical interests in Australia to produce ingredients for plastics, rayon, aspirin and a broad range of industrial and pharmaceutical chemicals.

Distillers will own 40% of the capital of the new company, which is to be called C.S.R. Chemical Pty. Ltd. The amalgamated concern will have a capital of about £A6,000,000.

AUSTRIA

Paper plant being built

One of the largest and most modern woodpulp and kraft paper factories in Europe is under construction at Nettingsdorf, in Upper Austria. Work was begun in the middle of last year. The new plant will produce packing paper and large bags for cement, fertiliser, meal, etc. Its daily production capacity is estimated at 120 metric tons. Operations are scheduled to begin early in 1953. This plant, which will be equipped with up-to-date machinery and installations, will be able to utilise those types of timber, and even wood waste, which hitherto could be used only as wood fuel.

BRAZIL

New cement factory

A new cement factory, which will eventually produce some 170,000 tons of cement a year, was recently opened. Production is due to start within the next twelve months. The factory is owned by a new company, the Companhia de Cimento Vale do Paraiba; it will utilise slag from the steel works of the Companhia Siderurgica Nacional. Total Brazilian cement production is now about 1,500,000 tons p.a.

BULGARIA

Fertiliser and chemical factory

The production of nitrate of lime began recently at the new ' Stalin ' fertiliser plant at Dimitrovgrad, Bulgaria, according to reports reaching Vienna. The plant is reported to have been constructed according to Russian plans and to be equipped with Russian machinery. Besides fertilisers, the plant is producing sulphuric and nitric acids, and liquid ammonia.

CANADA

Asbestos project

Plans for a new asbestos mill at St. Andrien, Quebec Province, have been announced by Dominion Asbestos Mines Ltd. The mill, which will process lead ore, will have a capacity of 2,200 tons daily. Construction will be started shortly and is

scheduled for completion by early 1953. The cost of the project is put at $1,425,000.

Drilling on the property has indicated an ore body containing about 23,000,000 tons, sufficient to feed the mill for 35 years. Laboratory tests show that the fibre is of high quality, with an unusual resistance to deterioration during milling and manufacturing operations. The tests have also indicated that all the current commercial grades can be produced.

FINLAND

Chemical imports permitted

The Finnish authorities are, until further notice, willing to grant licences for the import of certain commodities in quantities sufficient to meet home demand. Some of the products which must be paid for in sterling or transferable sterling are:

Sulphur, graphite, magnesite, gypsum, asbestos and talc.

Asphalt, carbolic acid, creosote and creosote oil, vaseline, paraffin, phosphor, quicksilver, acids, bases and oxides, and borax.

Carbonates, water-glass, sodium and calcium phosphate, colophony and tannin extracts.

Dye and colour extracts, pigments, casein, albumin, raw rubber, sand and quartz.

Fireproof clay, camphor, opium, medicinal plants, castor oil, glycerin, *x*-ray apparatus and film, sera and vaccines, optical glass, microscopes, water and gas gauges, and medical and surgical instruments.

FRANCE

Paint industry developments

The rapid development of the French chemical industry since the end of the war is expected to increase supplies of raw materials for paints, and some of the investment funds under the Monnet Plan are scheduled to be used for products which will benefit paint manufacturers. Of special importance will be the estimated increase in production capacity for methanol—from 25,000 to 62,000 metric tons by the end of 1953. The plan also contemplates expanded capacity for coal-tar derivatives by replacement and modernisation of equipment.

Lack of capital and the uncertainty involved in the manufacture of chemical specialities for paints deter further expansion of that branch. An important trade source states that such materials change so rapidly as new products are synthesised that manufacturers are reluctant to invest large amounts of capital in equipment for making items which may soon be obsolete. The most favourable sphere for expansion seems to lie in the production of wood distillates and related synthetic commodities and coloured lakes and pigments, because of the ready availability of the raw materials.

GERMANY

Second successor company to I.G. Farben

The second successor company of the former I.G. Farben Chemical Trust, the Farbenfabriken Bayer A.G., was recently established in W. Germany. Original capital was first fixed at D.M. 100,000. It is expected to be raised to several hundred million marks within the next few months, after most of the assets of the old Farbenfabriken Bayer and possibly also the Dormagen factory, also a member of the former Farben combine, have been transferred to the new successor company. Last year Bayer exported about 34% of its total production, compared with 50% before the war. Main export items were dyestuffs, chemicals and pharmaceuticals. The latter held the first place before the war.

The firm hopes to extend its production programme. It also intends to intensify research work in synthetic fibres.

More fertilisers used

West German fertiliser consumption regained the pre-war level last year. Farmers used 361,000 tons of nitrogen in the fertiliser year 1950-51, against 345,000 in 1938-39, while the consumption of phosphoric acid, at 418,000 tons, compared with 413,000 before the war, and that of potash at 660,000 with 633,000 tons.

Present W. German production capacity for nitrogen is between 450,000 and 500,000 tons p.a., with a further increase in the offing, as war damage is still being made good.

Official plans, drawn up by the O.E.E.C. and the W. German Government, envisage a consumption of 450,000 tons of nitrogenous fertiliser in 1952-53. Expert circles estimate that a consumption of 550,000 to 600,000 tons p.a. is called for.

GREECE

New pine resin plant

A new pine resin processing plant has gone into production at Posidonia, Corinth. Financed by the Greek Agricultural Bank, the plant is equipped with the most modern stills, enabling it to deal with 30 to 40 tons of pine resin per day. It will serve the agricultural co-operatives of the Corinth area.

The resin yield of the Greek pine forests is estimated at 18,000 tons, p.a., compared with 28,000 tons before the war. The decline is attributed to war-time destruction.

Of the current output, some 4,000 tons of resin are used in wine making, while the remainder goes to the distillation plants, yielding some 10,000 tons of rosin and 3,000 tons of turpentine. Domestic consumption accounts for about 2,000 tons of rosin and 500 tons of turpentine, the remainder being exported to Germany, Austria and Italy.

INDIA

New I.C.I. plastics research laboratory

The technical service laboratory of Imperial Chemical Industries Ltd. in a southern suburb of Calcutta was recently opened. It has been designed to assist principally the rubber and plastics industries and has been built at a cost of Rs.1,000,000.

The West Bengal Governor, Mr. H. C. Mookerje, speaking as the chief guest at the opening, said it was a good sign that foreign industries were realising the importance of associating Indians in their business. This, he believed, would be beneficial both to them and to the people of this country.

Welcoming Dr. C. V. Raman, the Nobel prizewinner, who opened the laboratory, Mr. N. D. Harris, chairman of the company, explained that the laboratory would undertake research on manufacturing problems in the plastics, rubber, leather and several other industries. More than half of the laboratory, which had a floor area of some 15,000 sq. ft., had been designed as a miniature factory or, rather, as a combination of factories where manufacturing processes could be faithfully duplicated and results of research related to factory practice. The laboratory would offer training facilities to customers' technical staff, and courses on chemicals, dyestuffs, and in water treatment had been arranged.

He also revealed that manufacture of *Gammexane* (benzene hexachloride), the insecticide which has been used with conspicuous success in the recent anti-locust campaign, will shortly begin in India.

Printing ink from cashew-nut shells

Research is being carried out by the Indian Council of Scientific and Industrial Research into the production of printing inks from cashew-nut shells and allied substances from indigenous sources. A semi-scale plant has been set up at the National Physical Laboratory in New Delhi. Good ink is said to have been obtained using 90% raw materials of Indian origin and several newspapers have tried out the ink with good results.

Oil refinery proposals

The Government of India have accepted the proposal by the Burmah-Shell group of oil companies for the establishment of a modern oil refinery in Bombay with a capacity of 1,500,000 tons p.a. This agreement follows broadly the lines of a recent agreement with the Standard Vacuum Oil Co., of New York.

The Burmah-Shell group will form an Indian company which will own and operate the refinery. In order to facilitate the project the Indian Government have given certain assurances to the Burmah-Shell organisation including exemption from compulsory acquisition for a period of 25 years, and from certain sections of

the Industry (Development and Regulation) Act. The company will be free to make its own arrangements for import of crude oil and for distribution of refined products in India; also to export such products as may not be required for the Indian market. The refinery is expected to begin operations in 1956.

A third refinery, to be run by the Caltex Oil Co., U.S.A., is expected to be established in the near future either at Madras or at Vizagapatam. Negotiations have already taken place. This project will cost some $35,000,000.

Lignite processing plant

A scheme for starting a pilot plant for the extraction and processing of lignite has been put to the Madras Government by Dr. Paul Eyrich, an American mining engineer.

The scheme is for the extraction of 20,000 tons of lignite in addition to quantities of china clay, fire clay, etc., on a site 500 ft. by 500 ft. The estimate includes cost of equipment such as earth-moving machinery, briquette-making machinery, montan wax manufacturing equipment, etc. Some of these items are available in India.

Details of the recently discovered lignite deposits in the Madras area were given in INTERNATIONAL CHEMICAL ENGINEERING, April, 1951, p. 186.

SOUTH AFRICA

British and Italian firms help to build cellulose plant

The new cellulose plant that is to be built in Natal with the help of Italian and British rayon concerns should start production by the autumn of 1953, according to a spokesman of the Italian Snia Viscosa company.

He made this statement on the conclusion of a tour of Snia Viscosa plants in north Italy by Mr. Havenga, South African Finance Minister, and Mr. Van Eck, chairman of the South African Industrial Development Corpn., which is providing South Africa's share in the capital of the new plant.

Capital of the company that is being formed to operate the plant will be £6,000,000, £2,000,000 of which will be provided by the South African Industrial Development Corpn., £2,000,000 by Courtaulds of Great Britain and £2,000,000 by Snia Viscosa.

Snia Viscosa will supply the machinery, technicians and manufacturing 'know-how' for the project. When the plant reaches full production, it is expected to produce £2,000,000-worth of exportable cellulose a year.

Big sources of uranium

Discussions on uranium production in the Union of South Africa, which began in October 1951 among Union authorities and representatives of the United States Atomic Energy Commission and the British Ministry of Supply, have been concluded. These discussions—a part of a series of such conferences begun in 1949—have been concerned with current and future aspects of the programme for the production of uranium from gold-bearing ores and residues. The joint discussions have been highly satisfactory.

On December 15, 1950, it was announced that an agreement had been made for uranium from South African gold mines, which constitutes one of the world's biggest known sources, to be made available to the British and American Governments. Four mining companies were named as being responsible for initial production. These were: West Rand Consolidated Mines Ltd., Daggafontein Mines Ltd., Blyvooruitzicht Gold Mining Co. Ltd., and Western Reefs Exploration and Development Co. Ltd. It was stated that ultimately South Africa may become one of the world's most important uranium producers (see INTERNATIONAL CHEMICAL ENGINEERING, 1951, January, p. 12, and June, p. 290).

WEST AFRICA

Uranium search

A British expedition has left Freetown on a geological exploration of Sierra Leone and the Gold Coast to discover whether uranium and thorium exist in that territory.

The British Ministry of Supply said the expedition are using a new type of Geiger counter detecting equipment, mounted in Land Rover vehicles, which automatically records the presence of radioactive elements in the subsoil of the country through which it is driven, and also shows whether the quantities are significant.

The party is led by Mr. Dennis Ostle, a senior geologist of the British Geological Survey (Department of Scientific and Industrial Research). He is accompanied by Mr. F. H. Hale, an electronics expert of the Atomic Energy Research Establishment of the Ministry of Supply. Officers of the Sierra Leone and Gold Coast Geological Surveys are collaborating in the research.

NORWAY

Aluminium production and prices

In its annual survey of the aluminium industry the Norwegian Aluminium Co. states that the world's total production of raw aluminium in 1951, excluding the Soviet Union, was between 1,300,000 and 1,400,000 tons. Norway's production was about 50,000 tons produced by Årdal Verk, Norsk Nitridaktieselskap, and Norwegian Aluminium Co. Norway's aluminium production will be increased by another 40,000 tons a year when the new Sunndalsöra plant comes into operation in 1954. Prices quoted by the Norwegian Aluminium Co. show that Norway, of all important European producer countries, has the cheapest aluminium—£117 5s./ton.

U.S.A.

Electric power from atomic energy

Electric power has been produced from atomic energy by U.S. scientists for the first time, the Atomic Energy Commission has reported. The power, more than 100 kW, was generated and used to operate pumps, reactor equipment and provide lights and electrical facilities at the National Reactor Testing Station at Arco, Idaho. The heat energy generated was removed from the reactor by a liquid metal at a temperature high enough to generate steam to drive a turbine.

The tests were carried out on an experimental basis, because the breeder reactor could never generate large amounts of electrical power. Cost was not an essential factor, and it was emphasised that no comparison should be made of the cost of producing electric power from this reactor with power from conventional sources.

The Commission said the experiment was not intended to show that electrical power could be economically produced from nuclear sources, but the technical information gained by the experiment might be useful in the design of future reactors aimed at generating electricity at a competitive cost.

A scheme, suggested by American private enterprise, for the development of a nuclear power station was reported in INTERNATIONAL CHEMICAL ENGINEERING, 1951, October, p. 467.

New synthetic rubber technique

A new technique that will increase the production capacity of the American rubber industry by 26% is being used at the world's largest rubber plant at Institute, West Virginia, according to Mr. S. S. Richardson, President of the B. F. Goodrich Chemical Co. The process, using sugar and other activators, was developed by the Goodrich Co., which operates the plant for the Government, to speed the manufacture of rubber.

He stated that the new formula was the first to be applied to the production of 'hot' synthetic rubber, which is made at 122°C., as contrasted with 'cold' rubber made at 41°C. 'Hot' rubber, which accounts for a substantial percentage of the current American rubber output, is in great demand for shoes, industrial materials, insulation and mechanical goods.

Rubber industry's situation

The U.S. industry will operate near capacity in 1952 to meet the demand for civilian and defence products, according to Mr. Humphreys, jun., president of the United States Rubber Co. Sales should run about 6% ahead of the record-breaking 1951 total of $5,000,000,000. He said that a return of the scare buying which prevailed during part of 1951 was not expected. The aggregate of natural and synthetic rubber available to the U.S. will exceed the ability to consume it. Certain kinds of synthetic

rubber are already in surplus supply and the Government plans to sell it to foreign consumers. There is also a glut of natural latex.

Production of chemicals and plastics, which are becoming increasingly important in the rubber industry, will continue to expand in the coming year. Research will be intensified to develop new compounds and new uses for these materials.

Insecticide prospects

Department of Agriculture sources consider prospects for supplies of insecticides during 1952 to be considerably better than last year. Among all the basic chemicals required for the manufacture of insecticides, sulphur presents the major supply problem and will continue to do so throughout the year, officials said. Lead supplies for the production of lead arsenate have eased somewhat since the National Production Authority has increased allocations to the industry. Between 30,000,000 and 35,000,000 lb. of this chemical were produced in 1951 and the same output is expected for this year.

Benzene hexachloride and other chemicals of this group are expected to be in adequate supply throughout the year, but copper sulphate is expected to get scarce.

New polyester laminating resin

The development of a new polyester laminating resin which will withstand temperatures as high as 500°F., has been announced by the Naugatuck chemical division of the United States Rubber Co.

The new resin is expected to be of most use as a structural material in the manufacture of high-speed aircraft and guided missiles. It is at present being tested for this purpose at the Wright Air Development Centre in Wright Field, Ohio.

The new resin has physical and handling properties comparable to other types of polyesters now available with the additional benefit of high strength at high temperatures. Laminates made with the resin and glass fabric retain a good flexural strength when exposed for as long as 200 hr. at a temperature of 300°F., and 24 hr. at 500°F. The heat-resisting properties of the resin are made possible by the use of a new chemical, triallyl cyanurate.

The resin will be initially available for military applications. However, Naugatuck Chemical is increasing production capacity in order to supply resin fabricators. It is being marketed as *Vibrin* X-1047.

YUGOSLAVIA

First asbestos factory

The first factory in Yugoslavia to make asbestos has been completed at Tuzla. The factory will process about 200 tons of asbestos mineral daily, sufficient for the manufacture of about 6,000 to 7,000 kg. of fireproof asbestos fibre.

MEETINGS

Institution of Chemical Engineers

February 12. 'Operation of the Dutch State Mines Cyclone as a Separator of Minerals,' by K. A. Fern, 5.30 p.m., Geological Society, Burlington House, Piccadilly, London, W.1.

GRADUATES' AND STUDENTS' SECTION

February 20. 'The Human Factor in the Design and Operation of Chemical Plant,' by W. Fletcher, 6.30 p.m., the University, Edmund Street, Birmingham.

February 22. 'A Small General-Purpose Plant for Pharmaceutical Development,' by V. C. Salvage, 6.30 p.m., Caxton Hall, Westminster, London, S.W.1.

February 29. 'The Place of Instrumentation in Chemical Plant,' by A. H. Isaac, 6.15 p.m., Chemical Engineering Department, Stephenson Building, Claremont Road, Newcastle-on-Tyne.

Society of Chemical Industry

February 7. Chemical Engineering Group. 'Extraction and Utilisation of Methane from Coal Measures, by Dr. D. W. Gillings, Nottingham.

February 15. 'Production of Sulphuric Acid from Calcium Sulphate,' by Dr. W. L. Bedwell, 7 p.m., Technical College, Brighton. Joint meeting with the R.I.C.

February 29. All-day meeting. 'Mechanical Properties and Testing of Plastics,' London.

March 3. 'Recent Progress in Ceramics,' by Dr. A. T. Green, 6.30 p.m., Chemical Society, Burlington House, Piccadilly, London, W.1.

Chemical Society

February 7. Symposium. 'Physical Chemistry of Structural Changes in Solids.' Contributions from the following will be read and discussed: Prof. A. R. Ubbelohde, Prof. F. E. Simon, Prof. W. E. Garner, Dr. J. S. Anderson, Dr. J. C. Kendrew, L. A. K. Staveley and H. D. Megaw, 2.30 and 7.30 p.m., Burlington House, Piccadilly. London, W.1.

February 7. 'Effect of Light on the Combustion of Hydrocarbons,' by Prof. R. G. W. Norrish, 7 p.m., The University, Bristol.

February 7. 'Developments in the Chemistry of Macrocyclic Pigments,' by Prof. R. P. Linstead, 6.30 p.m., The University, Manchester.

February 14. 'Applications of Infra-Red Spectroscopy to the Study of Plastic Polymers,' by Dr. H. W. Thompson, 7 p.m., Technical College, Gloucester.

February 14. 'Some Equilibria and Reactions with Sulphur,' by Dr. G. Gee, 5.15 p.m., University College, Dundee.

February 15. 'Some Recent Work on the Chemistry of Metallic Oxides,' by Dr. J. S. Anderson, 7 p.m., Royal Technical College, Glasgow.

February 18. 'Some Equilibria and Reactions with Sulphur,' by Dr. G. Gee, 7 p.m., The University, Leeds. Joint meeting with R.I.C.

February 21. 'Recent Trends in Refractories Research,' by Dr. A. T. Green, 7.30 p.m., North British Station Hotel, Edinburgh. Joint Meeting with R.I.C. and S.C.I.

February 21. 'La Liaison d'Hydrogène,' by Prof. A. L. Hunter, 6 p.m., University College, Hull.

February 22. 'Scientific Developments in the Field of Atomic Energy,' by Sir John Cockcroft, 5.15 p.m., United College, St. Andrews.

February 28. 'Photography as a Scientific Implement,' by Dr. H. Baines, 7.30 p.m., Marischal College, Aberdeen.

The Leonard Hill Technical Group

Articles published in some of our associated journals in the Leonard Hill Technical Group this month include:

Manufacturing Chemist—Manufacture of Dextran; D.C.M.X., a Potent New Disinfectant; Anethole; Progress Reports on Economic Poisons and Perfumery and Essential Oils.

Food Manufacture—Food Controls in Great Britain, Part IV; Automatic Control in American Food Plants; The Vitamins; Soft Drinks at Portslade; Mould Contamination in Pork Pie Manufacture.

Petroleum—Measurement of Viscosity under Pressure; Catalytic Dehydrogenation of Ethyl Naphthalene.

World Crops—Soil Improvements from Town Refuse in the Netherlands; Drying of Agricultural Products; The Rome Conference of the Food and Agriculture Organisation of the United Nations; Rainfall, Watershed and Stream Flow; Industry's Contribution to Agricultural Research, Part II, The Ford Motor Co. Ltd.

Atomics—Medicine and Atomic Energy at Oak Ridge; Handling Radioactive Isotopes.

Paint Manufacture—Solutions to Finishing Problems, Part I.

Textile Industries—Ductile Properties of Textile Fibres in Textile Processing.

Muck Shifter—Design and Construction of Claerwen Dam in Wales for the Birmingham Water Authorities; 'Mechanical Moke' Powered Barrow.

Building Digest—'Reema' Method of House Construction; Roofing of Schools.

Pottery and Glass—The New British Ceramic Research Laboratories at Stoke-on-Trent; Evolution of Tableware Shape.

March 6. 'Some Aspects of the Chemistry of Group IV Elements,' by Prof. W. Wardlaw, 4.30 p.m., The University, Liverpool. Joint meeting with the S.C.I., R.I.C. and the B.A.C.

Royal Institute of Chemistry

February 13. 'Chemicals from Petroleum,' by J. L. Edgar, 7 p.m., South-West Essex Technical College, Forest Road, London, E.17.

February 20. 'The Organisation of the Chemical Profession in the U.S.A.,' by Dr. R. L. Kenyon, 6 p.m., Waldorf Hotel, Aldwych, London, W.C.2.

February 23. Symposium. 'The Metabolism of Calcium and Phosphorus,' 2.20 p.m., The University, Reading.

March 3. 'Nature of Plastics,' by D. Mahon, 6.45 p.m., Woolwich Polytechnic, London, S.E.18.

March 5. 'Smoke,' by Dr. A. C. Monkhouse, 6.30 p.m., West Ham Municipal College, Romford Road, London, E.15.

Society of Public Analysts

February 19. 'Electrographic Analysis,' 6.30 p.m., Chemical Society, Burlington House, Piccadilly, London, W.1.

Incorporated Plant Engineers

February 12. 'Aspects and Problems of Modern Pumping Machines,' by J. F. Copp, 7.15 p.m., Institute of Engineers, Park Place, Cardiff.

February 12. 'Aspects on the Use of Creosote Pitch as a Boiler Fuel,' by S. C. Swann, 7.15 p.m., Engineers' Club, Albert Square, Manchester.

February 14. 'Utilisation of Refrigeration in War,' 7 p.m., Queens Head Hotel, Maidstone, Kent.

February 19. 'General Furnace Design and Operation,' by Messrs. Cowan and Little, Powell Duffryn Technical Services Ltd., 7 p.m., Engineering Centre, Sauchiehall Street, Glasgow.

February 20. 'Manufacture of Glass and its Applications,' 7.15 p.m., Grand Hotel, Bristol.

February 21. 'Steelmaking from the Plant Engineers' Point of View,' by F. Hinsley, Edgar Allen & Co. Ltd., 7.30 p.m., Grand Hotel, Sheffield.

February 21. 'Refrigeration,' by W. F. Ball, 7.15 p.m., Radiant House, Bold Street, Liverpool.

February 25. 'Further Advances in Metallurgy,' by Dr. Irvine, 7.30 p.m., The University, Leeds.

February 26. 'Modern Practice in Welding of Pipes,' by E. Fuchs, 6.30 p.m., Royal Society of Arts, John Adam Street, Adelphi, London, W.C.1.

February 29. 'Costing and the Plant Engineer,' by E. E. Mitchell, Guest, Keen & Nettlefords, Ltd., 7.30 p.m., Imperial Hotel, Birmingham.

Institute of Fuel

February 19. 'Measurement of Transient Temperatures,' by D. K. Mackenzie and R. Milne, 6 p.m., James Watt Institute, Great Charles Street, Birmingham, 3.

February 20. 'Thermal Factors in Furnace Design,' by Prof. R. J. Sarjant and W. Hulse, 7.30 p.m., Grosvenor Hotel, Chester. Joint meeting with the Institute of Petroleum.

February 20. 'Recent Developments in Gas Producers,' by Dr. F. J. Dent, 6.30 p.m., The University, Sheffield.

February 25. 'Modern Trends in Coal Preparation,' by Dr. G. F. Eveson, 7.30 p.m., The University, Birmingham.

March 7. 'Power in the Future,' by Dr. Bronowski, 7.15 p.m., Loughborough College, Loughborough.

Institute of Metals

February 7. 'Chromium and Chromium-Rich Alloys,' by Dr. A. H. Sully, 7 p.m., 4 Grosvenor Gardens, London, S.W.1.

March 4. 'The Direct-Reading Spectrograph,' by R. T. Staples, 6.30 p.m., Metallurgy Department, University College, Singleton Park, Swansea.

Institute of Petroleum

February 13. 'Lubricating of Gears and the Testing of Gear Lubricants,' by Dr. C. G. Williams, Shell Refining and Marketing Co., Ltd., 5.30 p.m., Manson House, 26 Portland Place, London, W.1.

Fertiliser Society

February 28. 'American Fertiliser Practices and Problems,' by Dr. E. M. Crowther, 2.30 p.m., Geological Society, Burlington House, Piccadilly, London, W.1.

Leeds Metallurgical Society

February 7. 'Low-Temperature Properties of Metals,' by D. W. Naylor, 7 p.m., The University, Leeds.

March 6. 'Recent Research on Aluminium and its Alloys,' by D. C. G. Lees, 7 p.m., The University, Leeds.

Manchester Metallurgical Society

February 20. 'Extrusion,' by J. Crowther, 6.30 p.m., The Engineers' Club, Albert Square, Manchester.

Liverpool Metallurgical Society

February 8. 'Some Technical and Economic Problems in the Conservation of Fuel,' by Prof. A. L. Roberts, 7 p.m., The University, Brownlow Street, Liverpool. Joint meeting with the S.C.I.

Liverpool Engineering Society

February 27. 'Aspects of Refrigeration Practice,' by J. Douglas, 6 p.m., 24 Dale Street, Liverpool. Joint meeting with the Institute of Refrigeration.

Hull Chemical and Engineering Society

February 12. 'Atomics,' by J. B. Moller, 7.30 p.m., Church Institute, Hull.

February 26. 'Hydraulic Operation of Cyclic Processes,' by I. T. Rushton, 7.30 p.m., Church Institute, Hull.

Oil and Colour Chemists' Association

March 3. 'Role of Controlled Lithopone Surfaces in Paint Making,' by F. Cooper, 7 p.m., Royal Station Hotel, Hull.

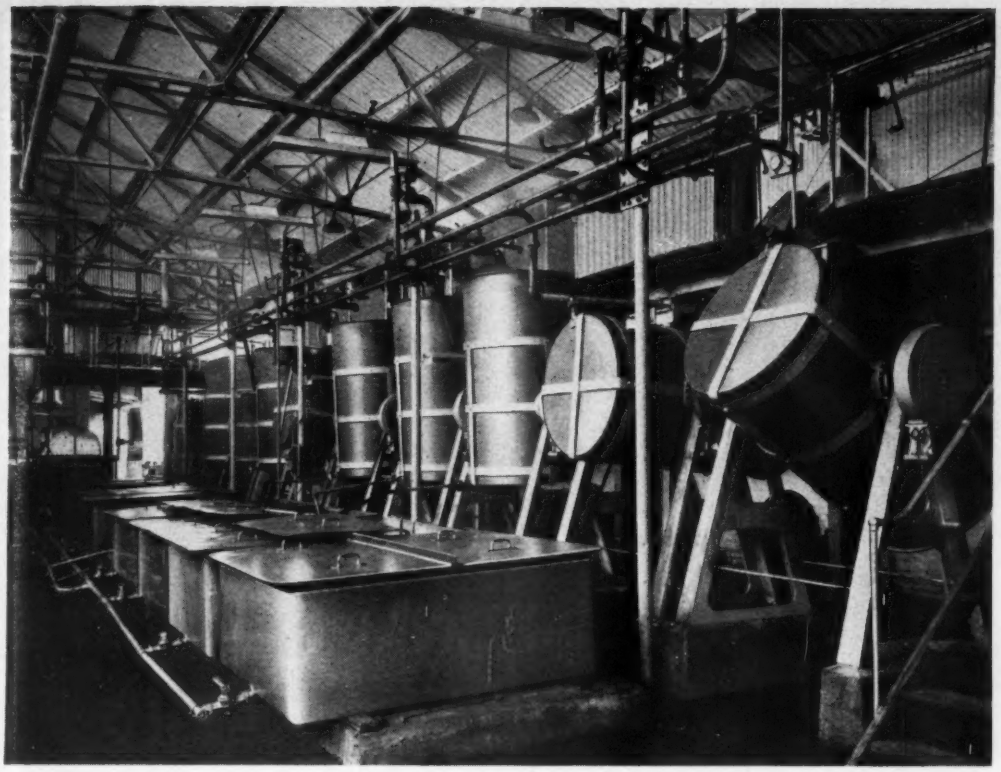
Institution of Works Managers

February 7. 'Current Aspects of American Management, by J. C. W. Stead, Batchelor's Peas Ltd., 7.30 p.m., Vane Arms Hotel, Stockton.

March 4. 'Thoughts on American Management, by J. C. W. Stead, 7.30 p.m., Grand Hotel, Sheffield.

INTERNATIONAL CONFERENCE

February 18. British Commonwealth Scientific Conference, organised by the Standing Committee of British Commonwealth Scientific Official Conference, 1946, Africa House, Kingsway, London, W.C.2. To be held in Australia.



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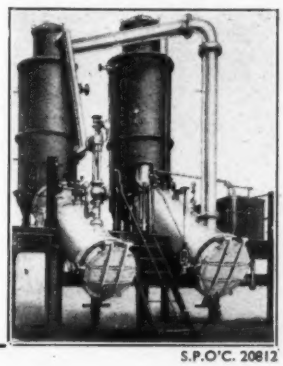

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